

W. G. FARLOW

HARVARD BOTANI

At a meeting of the Botanical Department held Oct. 20, 1903, the following vote was passed:

"Under the head of *Harvard Botanical Memoirs* it is proposed to include all quarto publications issuing from the Gray Herbarium, the Cryptogamic Herbarium, and the Botanical Laboratories of Harvard University, including theses presented for the degrees of Ph.D. and S.D. in Botany. Inasmuch as some of the future publications are likely to be continuations of subjects treated in quarto papers already published, it seemed desirable to begin the numbering of the *Memoirs* with the year 1880, the date of the first quarto publication of any member of the botanical staff at present connected with Harvard University."

At a meeting on Nov. 25, 1916, it was voted to discontinue the series of *Botanical Memoirs*. In all, nine numbers have been issued, the titles of which are given below.

- I. The Gymnosporangia or Cedar-Apples of the United States. By W. G. Farlow. *Anniversary Memoirs, Boston Soc. Nat. Hist.* 1880. Pp. 38. Pls. 1 and 2.
- II. The Entomophthoreae of the United States. By Roland Thaxter. *Mem. Boston Soc. Nat. Hist.*, IV, No. 6. Pp. 133-201. Pls. 14-21. April, 1888.
- III. The Flora of the Kurile Islands. By K. Miyabe. *Mem. Boston Soc. Nat. Hist.*, IV, No. 7. Pp. 203-275. Pl. 22. Feb. 1890.
- IV. A North American Anthurus: its Structure and Development. By Edward A. Burt. *Mem. Boston Soc. Nat. Hist.*, III, No. 14. Pp. 487-505. Pls. 49 and 50. Oct. 1894.
- V. Contribution towards a Monograph of the Laboulbeniaceae. By Roland Thaxter. *Mem. American Acad. of Arts and Sci.* Boston. XII, No. 3. Pp. 189-429. Pls. 1-26. Presented May 8, 1895. Issued Oct. 14, 1896.
- VI. The Development, Structure, and Affinities of the Genus *Equisetum*. By Edward C. Jeffrey. *Mem. Boston Soc. Nat. Hist.*, V, No. 5. Pp. 155-190. Pls. 26-30. April, 1899.
- VII. Comparative Anatomy and Phyllogeny of the Coniferales, Part I. The Genus *Sequoia*. By Edward C. Jeffrey. *Mem. Boston Soc. Nat. Hist.*, V, No. 10. Pp. 441-459. Pls. 68-71. Nov. 1903.
- VIII. The Comparative Anatomy and Phyllogeny of the Coniferales, Part II. The Abietineae. By Edward C. Jeffrey. *Mem. Boston Soc. Nat. Hist.*, VI, No. 1. Pp. 1-37. Pls. 1-7. Jan. 1905.
- IX. Contributions towards a Monograph of the Laboulbeniaceae, Part II. By Roland Thaxter. *Mem. American Acad. of Arts and Sci.*, XIII, No. 6. Pp. 219-469. Pls. 28-71. June, 1908.

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III.

CONTRIBUTION TOWARDS A MONOGRAPH

OF THE

LABOULBENIACEÆ.

BY

ROLAND THAXTER.

PRESENTED MAY 8, 1895.

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INTRODUCTORY NOTE.

IN the fourth volume of the "Memoirs of the Boston Society of Natural History" (No. VI, April, 1888), the writer published an account of the American forms belonging to the family of Entomophthoræ, with notes on all the species then known, which was intended to form the first of a series designed to include all the American fungi parasitic on insects. The subject was suggested to me by Professor Farlow, while I was a student in his laboratory, as one promising data of sufficient interest to furnish material for a doctor's thesis. The Entomophthoræ, however, having proved adequate in themselves to fulfil this requirement, the remaining entomogenous forms were laid aside in the hope that, at some future time, the original plan of a complete monograph might be carried out. In the paper just mentioned, a brief summary was given of all the fungi characterized by this peculiar parasitism; and, in addition to the family of Entomophthoræ, several groups were in a general way distinguished. Of these one comprises the entophytic and probably commensalist Schizomycetes (?) represented by the genus *Enterobrus* and its allies, to which might be added certain lower forms of the same order supposed to give rise to contagious diseases among insects; a second includes the perfect and imperfect or "iserial" conditions of the entomogenous species of the genus *Cordyceps* and its allies; while a third embraces all the members of the then small and little known family of Laboulbeniaceæ. To these should be added a few miscellaneous forms parasitic on insects; and perhaps, also, such fungi as are found in nature only on the remains or excreta of certain insects. The last, however, since they are saprophytic, cannot be called entomogenous in the more strict sense of the term.

Since the completion of the monograph above mentioned, I have accumulated material of entomogenous fungi whenever the opportunity has offered, but have found the number of forms so unexpectedly large that, as in the former instance, it has become necessary to abandon my plan of completing a monograph of all the remaining groups in a single paper. In view of this fact, the Laboulbeniaceæ have been selected as the subject of the present memoir, since they include by far the greater portion of the material referred to.

At the time when my attention was first attracted to the Laboulbeniaceæ by the discovery of several new species in the vicinity of New Haven, Connecticut, during the summer of 1890, it included six described genera (two of which have proved to be synonyms), represented by fifteen described species of which one only was from North America; while, of the remaining forms, two were from South America and the rest from Europe. To these, however, European writers have since added a single species, while my own observations have served very considerably to increase the total number of forms referable to this family. A greater portion of these additions have already been described in a series of papers which have appeared from time to time during the past few years in the "Proceedings" of the Academy, and serve as a systematic basis for the present monograph, in which will be found enumerated more than one hundred and fifty species from various parts of the world, distributed among twenty-eight genera. The labor and time involved in obtaining and studying the several thousand specimens which have been examined in the preparation of this paper and of the accompanying plates, can hardly be appreciated by any one who has not had personal experience of the many difficulties associated with the manipulation and study of these, for the most part, very minute plants. It is, therefore, needless to say that my investigations, carried on as they have been in connection with other occupations, are incomplete and unsatisfactory in many points relating to the structure and development of certain genera, for the proper study of which sufficient time or material, or both, have not been available; and although a certain amount has been done in connection with the nuclear changes which take place in the sexual organs before and after fertilization, I have been unable, as yet, to reach conclusions concerning them sufficiently definite to warrant their publication. The results obtained, however, although in very many respects imperfect, have served to demonstrate the unlooked-for numerical importance of the group, its great diversity, and, above all, have afforded definite information concerning the course of development of its members, as a result of which their pivotal position among the higher fungi is clearly indicated.

Of the species enumerated, more than half have been collected in New England by myself and studied while still living, the remainder having been derived from the examination of dead insects in the collections to which I have had access, or from insects sent in alcohol by numerous correspondents to whose kindness I owe very many interesting forms. For such favors I am under special obligations to Miss A. M. Parker, who has sent me many specimens of Carabidæ from Washington; to Prof. O. F. Cook, who has placed at my disposal all the Coleoptera collected by him in Liberia; to Mr. Theodore Pergande for many interesting specimens collected in or

near the District of Columbia; to Prof. Alfred Giard for the communication of several important specimens as well as references to literature; while the Rev. J. L. Zabriskie, Mr. M. A. Barber, Dr. H. M. Richards, Mr. J. M. Aldrich, Mr. William Beutenmueller, Prof. S. A. Forbes and Dr. G. von Istvanffi have also greatly assisted me by the communication of numerous specimens. I am also indebted to the kindness of Miss Helen Bondy, of Vienna, for a large number of house-flies collected in that city, from which were derived the important series of specimens of *Stigmatomyces Bueri* illustrated on Plate I. Special acknowledgment is, moreover, due to Mr. Samuel Henshaw, to whom I am indebted for the determination of the host insects, as well as for the privilege of free access to the collections under his charge, including the type collection of the late Dr. Leconte.

In making these acknowledgments, I may add that it is my intention to continue my studies of insect fungi as my opportunities permit; and that the communication of further material from correspondents, especially of Laboulbeniaceæ, will be greatly appreciated. I may also add the hope that, the family being placed with the publication of the present monograph on a moderately intelligible basis, from a systematic standpoint; it may not, like the other groups of entomogenous fungi, be reduced to a condition of chaos through the indiscriminate publication of new forms based largely on the character of the host or on its habitat; since, as we shall presently see, these are but uncertain guides in recognizing the species.

CRYPTOGAMIC LABORATORY OF HARVARD UNIVERSITY,
CAMBRIDGE, June, 1896.

MONOGRAPH OF THE LABOULBENIACEÆ.

PRESENTED MAY 8, 1895.

PART I.

IN the first part of this Memoir I have given an account of the History, Distribution, General Morphology and Development, Hosts, etc., of the Laboulbeniaceæ; while the second part comprises a systematic examination of the species and genera illustrating the family. Before entering, however, on the detailed consideration of the topics mentioned, it has seemed desirable, by way of introduction, to present a brief account of the more general characters of these plants.

Unlike the majority of fungi which subsist as parasites of living insects, the present group includes none of the conspicuous productions that are so characteristic among entomogenous fungi generally; and their usually minute size doubtless accounts, in some degree, for the fact that, although they are in certain respects among the most important of fungus organisms, they have been so long neglected by botanists and so generally overlooked or disregarded by entomologists. When examined *in situ* on the host insect, they appear in general like minute, usually dark-colored or yellowish bristles or bushy hairs, projecting from its chitinous integument either singly or in pairs, more commonly scattered, but often densely crowded over certain areas on which they form a furry coating. Unlike other entomogenous fungi also, the Laboulbeniaceæ can lay no claim to economic importance; and although they may be said to produce a contagious cutaneous disease, they give rise to none of the fatal epidemics which are liable to be associated with the parasitism of species of *Cordyceps* and *Entomophthora*. On the contrary, the very existence of these parasites would seem to be dependent on the fact that the host is not destroyed by their attack; since their own life ends with that of the insect to which they are attached, and their perpetuation from generation to generation and from year to year is undoubtedly dependent on the direct transference from one living insect to another of their reproductive bodies. So far, then, as they are at present known, they inflict

little if any appreciable injury on the host, and even when the latter is completely covered by them it shows no more marked signs of injury than is indicated by a greater restlessness, owing perhaps to a slight irritation which they may be supposed to produce. This absence of appreciable injury, associated as it is with true parasitism, is due to the fact that the habit of growth of the plants in question is an external one, unassociated, except in rare instances, with any penetration of well-developed haustoria into the body cavity, the parasite in almost all cases deriving its nourishment through at most a slight perforation of the host's integument. The hosts affected are all comparatively long-lived hibernating insects, and more or less continuous feeders; and in the present, as in so many other instances, are obliged to become the unwilling medium for the nutrition of an often numerous and varied population from which they are freed only by death.

An external parasitism, like that of the plants in question, on hosts living and as a rule actively locomotive, whether in water, in the air, or on the ground, would naturally be associated with a comparatively simple structure adapted to the exigencies of such a life; and a glance at the accompanying plates will show that such a simple type form may be traced in a general way throughout the group. A main body, or receptacle, is fixed by means of a blackened base, or foot, to the integument of the host, and consists in most cases of a very small number of cells differently arranged in different genera. This receptacle gives rise above to certain peculiar appendages of very variable form, commonly connected with the production of the male sexual organs; while from the same individual, with few exceptions in which the plants are dioecious, female organs are also variously produced from which perithecia are eventually developed. In the perithecia, which may arise singly or in considerable numbers from a given individual, and which are quite remarkable in structure, are produced the reproductive bodies or ascospores that are formed in asci identical in all respects with the organs thus named in other members of the great group of ascomycetous fungi. The ascospores thus formed germinate on the surface of the host to which they become attached by a blackened modification of their basal extremity, and, without the formation of any hyphæ, grow directly to new individuals by means of successive cell divisions. In respect to size the mature individuals vary considerably within certain rather narrow limits, for while the smallest species measure somewhat less than one-tenth of a millimeter in total length, a very few exceed a millimeter from base to tip, while by far the greater number do not attain more than half this length. Within the limits of size and fundamental structure just described, the opportunities for eccentricity of form seem, however, to have been abundantly utilized,

and the modifications which they present are so singular that the members of the group may well rank among the most remarkable of vegetable productions.

It is not to their variety and eccentricity of form, however, that they owe their special claim to interest and importance among plants in general and fungi in particular; but to the fact that, associated with their comparatively simple vegetative development, they present sexual phenomena the complicated nature of which would indicate that they occupy a position among the highest members of their class. It is hardly necessary to remark that any fresh evidence in this connection has a special interest at the present time; since, as a result of the views so strenuously maintained by Professor Brefeld and his school, the existence of sexuality of any type among the higher fungi, has become, to say the least, discredited by a majority of the mycologists of the present day. If we are to admit nevertheless, as seems quite unavoidable, that the Laboulbeniaceæ are fungi, and also, as seems equally unavoidable, that they are ascomycetous fungi in the strict sense of the term, it must also be admitted that they demonstrate the sexual origin of the ascus beyond any reasonable doubt. However views may differ as to the true phyllogeny of the group as a whole, the most devout disciple of the so-called "school" of De Bary could hardly have devised a series of forms better adapted than the present family to confirm his general conclusions. Despite this fact, one looks, as a rule, in vain for even a reference to the Laboulbeniaceæ in the host of text-books which have made their appearance within the past few years, while in the works of Professor Brefeld, so far as I have been able to ascertain, they are not even mentioned by name.

Further discussion of these matters may well be deferred, however, until the morphology of the more important genera has been considered, and with this brief note and general affirmation of my own views in regard to the vexed question of sexuality among the ascomycetes, we may turn at once to consider the family in detail.

HISTORICAL. In reviewing the literature relating to the Laboulbeniaceæ it will be noted that, although the list of titles is not a short one, a considerable number have reference either to brief notes or to articles which deal at second hand with previously published data, while the original contributions are comparatively few. A complete list of references, so far as I have been able to obtain them, will be found appended; but in briefly tracing the history of the family in so far as its literature is concerned, I shall omit reference to such articles as are not in the nature of contributions to a knowledge of the group.

This knowledge may be said to have originated with the publication by Robin of

his classic "Histoire Naturelle des Végétaux Parasites," in which, for the first time, the vegetable nature of these organisms was recognized. In this work two species are enumerated, for the reception of which the new genus *Laboulbenia* Montagne et C. Robin (e familia Pyrenomycetum novum genus) was erected; the generic name being selected in honor of the entomologist Laboulbène, who was, perhaps, the first to observe the *L. Rougetii* of these authors, which occurs on species of *Brachinus* in Europe. The second form, *L. Guerinii*, was obtained from a South American species of the aquatic genus *Gyretes*, and both are figured and described at considerable length. Although the spores are described, no mention is made of their origin; while the perithecia are spoken of as sporangia. It is, therefore, somewhat uncertain what this author's views really were in regard to the position and relation of the forms described, although the comment "Genus sphæriaceum, maxime singulare, entomogenum, quoad perithecium Capnodio analogum" would lead one to suppose that it was thought to be ascigerous.

Robin's materials were received in part, however, from the entomologist Rouget, to whom belongs the credit of the first published note on these parasites, which, as early as 1850, three years before the publication of Robin, he had described and figured in the "Annales de la Société Entomologique de France," under the title "Note sur une production parasite observé sur le *Brachinus crepitans*." He did not, however, recognize the true character of the organisms described, nor did he distinguish several different species which he must have had before him, if one may judge from the diversity of the hosts on which he states that he had observed this "production parasite." It may be mentioned also that in 1852 still another species of *Laboulbenia* was observed by Mayr, the *L. Nebrice* described many years after by Peyritsch, and was supposed by him to be a pathological condition of the insects chitinous integument.

During the next sixteen years little of importance was published concerning the group; but it is of interest to note that Prof. H. A. Hagen, in his well-known monograph of the Termites, mentions that he had observed on the larva of a worker of *Termes bellicosus* a *Laboulbenia* closely resembling the *L. Guerinii* of Robin, concerning which a further note will be found in connection with the subsequently described *L. Hageni*. In 1857 also, Kolenati, in a paper entitled "Epizoa der Nycteribien," described certain parasites on these wingless flies, which infest various species of bats, placing them among the worms in a new genus to which he gave the name *Arthrorhynchus*, including two supposed species, *A. Diesingii* and *A. Westrumbii*. Two years later (1859) Diesing, in his "Revision der Rhyngoden," made these two forms the types of a new tribe of Vermes, the *Arthrorhynchodeæ*, characterized by a quite

astonishing zoölogical anatomy. The same genus, it may be mentioned, was subsequently rechristened *Helminthophana* by Peyritsch, who placed it in its proper kingdom and family, its connection with the Laboulbeniaceæ having been previously pointed out by Brauer (1871).

In 1868 an important addition to the family was made by Knoch (1868), who described as *Laboulbenia Bæri* the interesting form, redescribed in the succeeding year by H. Karsten (1869) as *Stigmatomyces muscæ*, which occurs in middle and western Europe on the common house-fly. The paper of Karsten owes its importance to the fact that this writer was the first to recognize the presence of a highly developed type of sexuality in these plants, and although the account given is largely incorrect as to the details of morphology and development, the important fact of the existence of a trichogyne fertilized by antherozoids is distinctly emphasized and rightly compared to the similar conditions present in the Florideæ. The use by this writer of such terms as "archegonium" render it uncertain what his opinion as to the true position of the plant was at this time. In a later work (1895) the same writer includes all the Laboulbeniaceæ in a group of "Stigmatomycetes," placed between the Ustilagineæ and the Pyrenomycetes. The same form, it may be mentioned, was redescribed in 1872 by Sorokin as *Laboulbenia muscæ*.

With the exception of a note by Robin in his "Traité du Microscope," where he figures *Rhachomyces pilosellus* (Robin) Thaxter, no further contributions of importance are met with until the publication by Peyritsch of the first of his well-known papers on the family (1871), in which he describes and figures the "*Laboulbenia Bæri*" of Knoch already referred to, as well as the *Arthrorhynchus* of Kolenati, discarding the generic and specific names given by this writer, and designating the species as "*Laboulbenia Nycterybia*." In this paper the existence of asci was somewhat doubtfully made out; but the sexual process described by Karsten was not observed. A new form, *Laboulbenia Nebriæ*, was also described and figured.

Two years later (1873) a second paper by the same author made its appearance, in which several new species and genera were described and figured, and a synopsis of the whole family appended. In this paper the author for the first time recognizes in a measure the grounds which have proved to be the determining factors in connection with generic distinctions in the group. The forms enumerated are twelve in number, distributed among five genera, one of which must now be regarded as a synonym. The general morphology and development is described, in so far as it was then understood; but not without many inaccuracies, the sexual processes being undetermined, except in so far as concerns the existence of a trichogyne, which was

observed and figured in several instances. The developmental relations between the appendage perithecium and receptacle were accurately made out in connection with the two genera *Laboulbenia* and *Stigmatomyces*, and the origin of the asci as buds from some central cell was suggested. The asci were not, however, accurately observed. A third paper by Peyritsch, published in 1875, contains additional notes on the development and occurrence of the Laboulbeniaceæ, without, however, making any essential contribution to previously published data. In none of the papers of this writer are the characters of the male organs determined, and he seems to incline to the opinion that the latter are represented by the shorter branches of the appendages, which he regarded as pollinodia and supposed to conjugate with the trichogyne.

Following these publications of Peyritsch, we have in 1884 the suggestive summary by De Bary of the characters of the group so far as then known in the "Doubtful Ascomycetes" of his *Morphology and Biology of the Fungi*, etc. In 1886 occurs the note of Gerke, to which my attention was drawn through the kindness of Professor Giard, in which he gives a figure that, without doubt, is intended to represent the "*Appendicularia entomophila*" of Peck, published two years later. In the same year (1886), Karsten published in *Hedwigia*, under the title "Doubtful Ascomycetes," a reassertion of his former observations on the sexuality of *Stigmatomyces*, in reply to the publications of Peyritsch and De Bary already mentioned, denying their ascomycetous nature and giving what he supposed to be the method by which the spores were formed.

In 1889, Berlese again summarized the group, adding to the thirteen species then known a new form (*Laboulbenia armillaris*) found on an acarid from South America. With the exception of the writer's own notes on the family, but two papers published since the one just mentioned remain to be noticed: that of Giard (1892), in which he describes, as a new genus *Thaxteria*, a remarkable species of *Laboulbenia* from the Javan Mormolyce; and that of Istvanffi (1895), in which he redescribes as *Laboulbenia gigantea* a large form of *L. elongata*, giving his impressions of its morphology and development, stating his disbelief in the sexuality of the group, and expressing the erroneous opinion that the individuals are derived from a vegetative portion growing within the body cavity of the insect.

GENERAL MORPHOLOGY AND DEVELOPMENT.

Spores. The spores of the Laboulbeniaceæ present a uniformity of form and structure quite remarkable for so varied a group, being in all cases, without exception, hyaline and fusiform or acicular in shape; and although in the single genus

Amorphomyces they are continuous (Plate V, fig. 29), in all others they are divided into two cells by a septum or pseudoseptum. In the great majority of cases the two spore segments are of unequal size; that which is terminal in relation to the axis of growth being, as a rule, much the longest: although in a few cases, as in *Zodionomyces* and *Ceratomyces* (Plates XXIV to XXVI), the reverse is true; while in still other instances the septum may be more nearly median, as in *Compsomyces* (Plate XI, fig. 15). The spore contents usually consists of more or less homogeneous granular protoplasm, except in the genus *Amorphomyces*, the spores of which when living contain numerous, often large, oil globules. In all cases a large spherical nucleus may be, as a rule, readily demonstrated in either segment (Plate I, fig. 13). A gelatinous envelope, more or less well developed and characteristically thickened about its base, always surrounds the spore; serving as a protective covering for the latter as well as facilitating its adherence to the host insect when it comes in contact with its surface. In the majority of cases this envelope, though often adherent about the tip of the spore, is continuous around it; but in *Ceratomyces furcatus* and *C. contortus* (Plate XXV, figs. 4 and 10) the separation between the spore segments involves the envelope also, which is marked by a corresponding constriction.

The spores are produced in the asci in fours or eights (Plate XXIV, fig. 9, Plate XI, fig. 17), in the first instance usually disposed more or less definitely in pairs, one of which is slightly higher than the other; and the members of a given spore pair are discharged together through the pore of the perithecium, the ascus wall having been previously absorbed. The juxtaposition of two individuals at the point of contact with the host, a condition essential for the perpetuation of the dioecious species, is thus insured in a majority of cases (Plate III, fig. 5). The spores are formed in the ascus, and therefore lie in the cavity of the perithecium after the wall of the latter has been absorbed, with the basal half uppermost; and the base is therefore directed towards the substratum on which it is discharged. Having become attached to a proper host, the swollen portion about the base, by its peculiar form, assists the spore in assuming the position necessary for germination; the upper extremity, if at first adherent, soon freeing itself and projecting from the substratum at an acute angle. A conspicuous exception to the conditions just described is found in the genus *Moschomyces*, the minute spores of which are irregularly distichous in the eight-spored ascus, and become free in a mass within the distal portion of the perithecium, whence they are discharged, not in pairs but in small masses, each mass probably giving rise to the so-called individual, which may thus in reality be compound (Plate XI, figs. 16 and 18).

The transfer of the spores from one host to another is probably accomplished, as a rule, by the direct contact of two insects; as, for example, during coitus, perhaps never otherwise in the aquatic species, as might be inferred from the remarkable constancy with which some of these forms occur in definite positions on the elytra or elsewhere; but may doubtless be otherwise effected, at least in cases where more or less gregarious hosts inhabit or hide during the day in moderately moist situations. Under these conditions it is not improbable that spores discharged upon materials with which such insects have come in contact may subsequently adhere to other individuals on which they may develop. Although a gelatinous envelope is always a protection of extraordinary efficacy, it does not seem probable that the spores can retain their power of germination for any considerable time, at least in a dry condition.

Having reached a proper host, and having adhered to it by virtue of its generally viscous character, the sporè begins to germinate at once.

Germination. The first indication of germination in the spore usually consists in the modification of its lower extremity into a blackened organ of attachment, the *foot*; the blackening resulting from a change which takes place in the gelatinous envelope in this region by which it becomes converted into a black, opaque, hardened, more or less elastic medium of attachment to the host. This conversion of the lower portion of the basal spore segment into an indurated organ by which the growing plant adheres firmly to the substratum on which it grows, is apparently unconnected with any effect resulting from contact with the chitin of the insect; since, in exceptional instances, where the usual discharge of spores has been prevented from any cause, the latter, while still within the perithecium, may begin to germinate and even attain an advanced development (Plate V, figs. 1 and 19). In such cases the first step in the process consists, as in normal germination, in the formation of a blackened foot of the usual type. A foot of this nature is not, however, invariably present. If the figures of Peyritsch are to be relied upon, there is no such blackening in the case of *Helminthophana* (Plate VIII, fig. 10), which is represented as penetrating the integument of the insect on which it grows by the intrusion of a papillate haustorium, there being no blackening whatever of the basal cell. The typical foot is also conspicuously absent in certain other genera. In *Moschomyces* also, to which reference has been made above, this organ is not differentiated; and the plant penetrates the soft integument by means of a cellular haustorium which, expanding within the body cavity of the host, holds the parasite firmly attached. The most striking exception, however, is presented by the genus *Rhizomyces*, in which the penetrating haustorium reaches a development quite beyond that of any other form. In this case (Plate

IV, figs. 1 and 3) the basal cell sends into the body cavity of the host a copiously branched and well-developed rhizoid-like organ, the interior of which is apparently continuous with that of the basal cell.

In cases where a typical foot is formed, it may constitute a cell distinct from the basal cell of the individual, as is at least often the case in *Stigmatomyces Bæri* (Plate I, fig. 14), a condition which may very likely exist in many other instances, although obscured by the blackening already mentioned. In some instances this blackening involves more than the basal cell of the mature plant, as in some species of *Ceratomyces* (Plate XXV, figs. 15 to 17).

In forms like those just mentioned in which a definite haustorium is present, it is quite evident that this organ constitutes the means by which the parasite absorbs from its host the nourishment necessary for its growth, and at the same time serves to fasten it securely. In the great majority of instances, however, it is probable that there is no intrusion of any kind from the ordinary form of blackened foot into the substance of the host. That this is the case may be clearly seen in preparations in which the parasite is shown attached to some transparent portion of the host's integument, as in fig. 4, Plate III. In the specimen here represented several individuals were fixed to the surface of the thin integument of one of the abdominal segments of the host, the substance of which was perfectly transparent, so that by inverting the piece to which they were attached, so as to view its lower surface, one could observe with accuracy the relation of the adherent portion of the foot to the chitinous surface to which it is applied. In such a specimen it is evident that this sucker-like adherent portion consists of a flat area in the closest contact with the chitin of the integument, and consisting of a thin membrane through which the absorption of nutriment takes place, bordered, as in the figure cited above, by the thick base of the indurated external wall of the foot proper. It should be mentioned, however, that Peyritsch figures sections of a fly's integument which indicate a slight penetration through the pore canals in the case of *Stigmatomyces*.

In addition to its function of attachment and absorption the foot may, in some of the aquatic genera more particularly, perform the office of a fulcrum on which the plant is supported and by means of which it is allowed a certain freedom of motion which it could not otherwise attain. This is effected through the more or less sudden and distinct enlargement of the foot above its point of attachment. The rounded fulcrum thus produced rests on the surface of the host, allowing the body of the plant, although appressed, to lie free from the insect and to roll upon it from one side to the other, as far as the elasticity of the attached portion will permit. This is most clearly

seen in Chitonomyces (Plate XXVI) or Hydroëomyces, both of which genera inhabit hosts that live, for the most part, submerged, and which are rapid swimmers. Under these conditions of life the advantages of such a contrivance, to allow a certain freedom of motion, are sufficiently apparent. The same office of a fulcrum for the support of the perithecium is effected in some species of Ceratomyces by the conversion of a considerable portion of the receptacle into a foot-like organ (Plate XXIV, fig. 1).

After having become attached to the insect, and during, or sometimes before, the formation of a definite foot, the spore elongates more or less distinctly and becomes further divided by the formation of transverse septa into a series of superposed cells, varying in number in the different species and genera, from the further development of which result the three fundamental parts of which these plants are usually composed: namely, a main body, the *receptacle*; one or more spore-producing portions, the *perithecia*; and lastly, one or more *appendages* which, in the majority of cases, are associated with the formation of the male sexual organs.

The Receptacle. The term "receptacle" has been used to designate that portion of the fungus on which the appendages, together with the perithecia or their stalk-cells, are inserted; but it is necessarily used with some looseness, and is sometimes unavoidably applied to series of cells which are neither homologous in origin nor similarly related to the other essential organs of the plant. In the genus *Laboulbenia*, for example, the whole body of the individual, exclusive of the appendages and perithecium, is spoken of as the receptacle; although, in this instance, it consists fundamentally of the usual two superposed basal cells, while distally it is formed from a consolidation of the stalk-cell of the perithecium (cell VI), which has become laterally united with what is in reality the base of an appendage (cells III-V). In other cases it is often difficult to determine exactly how the receptacle should be limited, as, for example, in the genus *Chætomyces* (Plate XI, fig. 20), in which it consists of a single series of superposed cells which give rise directly to perithecia or to appendages.

The simplest type of receptacle, which is found in more than half of the genera, consists of only two superposed cells, the upper of which bears the appendage, at first terminally; while the perithecium, or perithecia, if there are several, are lateral productions from the same cell. This type is well illustrated by such genera as *Haplomyces* and its allies (Plate VII) *Compsomyces* (Plate XI, fig. 7) and similar instances; while, as has been above indicated, even genera like *Laboulbenia* are fundamentally similar. In other genera various degrees of complication are found in the development of the receptacle which passes gradually from the simple two-celled type to

such highly developed forms as are present in *Zodiomyces* (Plate XXIII) in which it attains its maximum development as compared with other known genera of the group. Other multicellular forms may be illustrated by such genera as *Chaetomyces* or *Enarthromyces* (Plate XI, fig. 20 and IV, fig. 8), in which it consists of a single row of superposed cells, and *Rhachomyces* (Plate XII), in which, from a similar simple axis a series of appendiculate cells is cut off on one side, the predominance of transverse divisions resulting in an elongate form. As an illustration of the reverse condition where a predominance of longitudinal divisions is present, genera like *Dichomyces* or *Diplomyces* may be mentioned, in which the habit is stout and compact, this type reaching its greatest complication in the genus *Zodiomyces* just referred to.

Although the number and arrangement of the cells which form the receptacle in a given genus is often very constant, this is by no means invariably the case; and, even in the same species, fixity in this respect does not always exist. In *Peyritsiella*, for example (Plate VI), although the individuals of a given species do not vary greatly, in so far as the number and arrangement of the cells is concerned, no two species are alike in this respect. The same is true to a more marked degree in *Rhachomyces* (Plate XII), a genus which is further remarkable from the fact that the main body of the receptacle is in the nature of a lateral proliferation from the sub-basal cell of what may be termed the primary receptacle, as well as from the fact that this proliferation may be once or several times repeated, as will be presently noted. Again, in *Ceratomyces* there may be wide variations in this respect, not only between different species, but in individuals of the same species; while in other instances in this genus the number and arrangement of the cells of a given species may be invariable.

In the simple as well as in the more complicated forms, the receptacle is more or less flattened, usually in an antero-posterior plane, the side bearing the appendage in the mature individual being considered for convenience "posterior," where this distinction is possible. In some instances, however, the flattening is in a plane at right angles to that just mentioned, as in *Dichomyces* and *Diplomyces*. In a majority of instances this flattening is well marked; but it is most pronounced in forms which have a distinctly appressed habit of growth in relation to their substratum.

Appendages. With but a single exception in the whole group of Laboulbeniaceæ, the receptacle gives rise to one or more appendages which, though not invariably, are, as a rule, clearly distinguished from it, as well as from the perithecium. These appendages, though extremely variable, and affording, in many cases, excellent specific distinctions, are chiefly important from the fact that they are, with few exceptions, associated with the production of the antheridia or male sexual organs of the plant. In

all cases the primary appendage is originally a terminal structure, developed at least in part, often entirely, from the terminal spore segment, which is as a rule distinctly smaller than the basal, and never under any circumstances concerned in producing any portion of the true receptacle. While this terminal character of the primary appendage is often obscured, as in *Zodiomyces*, *Rhachomyces* and other genera, it is in many cases sufficiently evident; for example in such instances as *Stigmatomyces* (Plate I, figs. 2-13), *Cantharomyces* (Plate VII), and the like. In the genus *Rhachomyces* the primary appendage is represented by the single small bristle at the very base of the whole series of appendages, which are thus nearly all secondary and quite different in origin from the originally terminal primary one. Again, in *Zodiomyces* the originally terminal primary appendage is soon sloughed off, its place being taken by a multitude of secondary ones, also quite different in origin.

Although they are very important from a systematic point of view, it would be quite superfluous in the present connection to enter into any detailed description of the many variations of form and structure which the appendages, both primary and secondary, exhibit; and further details should be sought in the special descriptions of the genera. It is sufficient for the present purpose to say that the appendages, using the term to include both primary and secondary, may be solitary or very numerous: greatly elongated or consisting merely of single short cells; simple or branched in a great variety of ways, either sympodially or monopodially, or more or less irregularly; hyaline or deeply colored; stiff and bristle-like or flexuous and slender; in short, as may be seen by a glance at the accompanying plates, showing wide variations as to minor details even in nearly related forms.

The sterile appendages, or the sterile portions if such are present of fertile appendages, which are always more or less filamentous and composed of successive cells placed end to end, may become very highly developed, forming a dense tuft which is often much more conspicuous than the main body of the plant itself. The function of such highly developed sterile branches is doubtless primarily that of protection for the delicate trichogyne, which is subsequently developed, and they may, perhaps, have a further office in facilitating the fertilization of this organ by holding around it a drop of water, which is usually found at times condensed on the surface of the hosts, the majority of which are apt to hide by day, at least, in cool moist situations. It might be supposed that since these sterile portions of the appendages extend, in many cases, beyond or around the tip of the perithecium, that they were of some assistance in the dissemination of the spores; but it is a curious fact that the latter, despite their generally viscous nature, are only in exceptional cases found adherent to any portion

of them; and it seems certain that they do not thus act as brushes for the more convenient transfer of these bodies. In general the ultimate filamentous sterile branches, or branchlets, consist of a single series of superposed cells which appears to elongate, at least in so far as I have been able to determine, through the successive division of the terminal cell.

One curious structure, the significance of which is as yet undetermined, should be mentioned before leaving the sterile portions of the appendages. This structure consists of a spine-like process laterally developed from the primary appendage, and has been observed in only a few instances. It is most pronounced in an apparently undescribed genus parasitic on *Tachinus pallipes*, which has not yet been found in a mature condition. It also occurs in *Sphaleromyces Lathrobii* (Plate XI, fig. 19) and in *Rhadinomyces cristatus* (Plate IX, fig. 22), in both of which it seems to disappear at an early period. The process which is persistent at the summit of the antheridium in *Haplomyces* may also be of a similar nature.

Male Sexual Organs. As has been previously mentioned, the essential function of the appendage, apart from the secondary function of protection which it undoubtedly subserves in many cases, is as a rule connected with the production of the male sexual organs; although in the following genera, *Amorphomyces*, *Dimorphomyces*, *Dimeromyces*, *Enarthromyces*, *Peyritschiella*, and *Dichomyces* (probably also in *Chitonomyces* and *Hydræomyces*), the latter are wholly independent structures unconnected with the sterile appendages which usually accompany them.

A comparison of the character of these male organs in the different genera makes it apparent that they afford the best, indeed the only basis for the natural separation and grouping of the members of the family as a whole, which are thus distinguished into two main categories: one including those forms having male organs from which the male elements are produced exogenously; the other including those forms in which the male element arises endogenously. Of these groups the first may be further subdivided, on a similar basis, into forms in which the male organs are borne on specialized male individuals, and those in which the sexes occur together on the same individual. Again, as will be seen presently, these monoecious and dioecious groups are further distinguished according as the male organs are simple or compound; while their relative position, distribution, etc., afford opportunities for minor subdivisions.

Since they are undoubtedly homologous with similar structures in the Florideæ, the male organs and male elements in the Laboulbeniaceæ may be properly designated as *antheridia* and *antherozoids*, respectively; the former, as will be seen, consisting of a

single "antheridial cell," or a group of such cells, the latter of a single naked or thin-walled cell.

If we separate the genera of Laboulbeniaceæ, on the basis above outlined, into forms with endogenous and those with exogenous antherozoids, it will be found that it is only in two aquatic genera that the forms included in the first-mentioned category occur: *Zodiomyces* and *Ceratomyces* being the only instances in which this type has been definitely observed. In general the antheridial branches are not highly differentiated even in the more typical instances; while were the demonstration of the existence of male elements of this type dependent on the data afforded by the less well-marked examples, one might be inclined to doubt the presence of any sexuality in such cases, despite the presence of a well-developed trichogyne. In *Zodiomyces*, however, the antherozoids are produced in the form of buds which arise from the tips of short special branches (Plate XXIII, figs. 21-23) which assume a rod-like form and eventually fall from their attachment. These bodies have a definite wall and seem to be sought by the tip of the trichogyne in a fashion to which reference will be made below. A second well-marked instance is found in *Ceratomyces rostratus*, from the antheridial branches of which are developed rods of definite form and size, which become separated and adhere to the trichogyne. In this instance the rods are formed successively from a definite point at the distal end of the fertile cells of the antheridial branch (Plate XXIV, figs. 23-24), each rod usually becoming detached from its point of origin before its successor has begun to form. In other species of the genus, however, these bodies are not so clearly differentiated, and seem to be replaced by slender, often long, filaments which eventually break up into rods that are presumably functional as antherozoids. The adherence of the antherozoids to the mother-cell, or to one another, as in the last two instances mentioned, may be assumed to render fertilization more certain; since it is evident that were such bodies separated, as soon as they were mature, from a plant growing, as in the present instance, on an isolated and rapidly swimming host, the chances of their ever coming in contact with and adhering to the trichogyne would be reduced to a minimum. In view of the fact that this separation does not seem to take place at once, and that the long slender trichogyne must, from its position, inevitably be continually brought into contact with them while still *in situ*, through the motion of the plant which would necessarily result from the activities of its host, it seems quite probable that such antherozoids, in order to be functional, must become detached at the moment when they come in contact with and adhere to the trichogyne.

In all other genera of the family the antheridia are more complicated in

structure, consisting of highly specialized cells, or groups of cells, within which the antherozoids are formed endogenously and from which they are discharged through a special orifice in the form of free, naked, or nearly naked protoplasmic masses. Among such antheridia two distinct classes may be clearly distinguished, which I have termed *simple* and *compound*, respectively: although instances occur in which antheridia of the "simple" type are so closely associated that they may be regarded as transitional forms between the two types. In the first class, the simple form is characterized by the fact that the antheridial cell is quite independent of any similar cells, however closely they may be united to it, and discharges its antherozoids into the surrounding medium through its proper mouth. In the second instance, on the other hand, several such cells, closely associated to form a specialized organ, discharge their antherozoids into a common cavity from which the latter make their escape into the surrounding medium through a single aperture.

The *simple antheridium* (Plate II, fig. 15) is usually a more or less flask-shaped cell, which may be solitary or associated with similar cells grouped together with or without regularity. Although in *Amorphomyces*, a genus wholly destitute of appendages, it results from the direct modification of the terminal portion of the germinating spore (Plate V, figs. 20 and 23), it originates in other genera as a terminal or lateral outgrowth from the appendage or its branches. In a majority of genera, if it does not terminate the appendage or one of its branches or branchlets, the antheridium is itself a branchlet, as, for example, when it is sessile; but in a few instances this terminal character is lost and the organ is formed as a definitely intercalary cell, as in *Rhadinomyces*. In the compound type, these cells seem always to be intercalary in origin, although material has not been available for the study of their development.

The form of the simple antheridium is remarkably constant, the single cell of which it is composed being distinguished, more or less abruptly, into a basal, somewhat inflated portion or venter; and a terminal, more slender, usually sub-cylindrical portion, the neck, originally developed as a terminal outgrowth, which, at maturity, becomes perforate at its apex for the discharge of the male elements. The cavity of the venter is separated from that of the neck by a kind of diaphragm, abruptly distinguished on the venter side, and much less so on the neck side. This diaphragm, which seems to be formed by the deposition of a ring of cellulose in the position indicated, is perforate in the middle so as to allow the contents of the venter to pass out into the neck through an opening which is much smaller than the diameter of the cavity of the neck itself (Plate I, fig. 26). The cavity of the neck therefore, which may be conveniently called the canal, though of about the same diameter throughout the

greater portion of its length, is more or less abruptly narrowed just before passing into the venter. The contents of the venter during its active period, as it increases in volume, pushes through the narrow opening in the diaphragm into the cavity of the neck, and the portions thus extruded, when they have reached a certain definite size, become separated from the mass whence they were derived; and, assuming the form of short cylindrical rods, the antherozoids pass into the general cavity of the neck, the diameter of which is but slightly larger than their own, and thence make their final exit through the terminal pore. This process of abjunction, by which small but uniform pieces become separated from the contents of the venter as it is pushed into the neck, continues for a period which varies somewhat in different cases, but may begin some time before the female organs are mature, and continue long after they have been fertilized. Although one sees many cases in which the neck contains a continuous series of antherozoids which are evidently pushing one another out through the terminal opening, these bodies seem to be able to make their exit quite independently of one another, although at the same time they also appear to lack any indication of a power of independent motion, amoeboid or other.

As has been already mentioned, the form of the simple antheridium is subject to inconsiderable variations which depend in general on the relative development of the neck or of the venter, the latter being sometimes short and stout and abruptly distinguished, while in other cases it may run gradually into the neck without any such clearly marked differentiation. The neck, too, may be short and rather stout, or long and slender, straight or curved, the extremes in these respects being illustrated by such instances as the following: *Laboulbenia decipiens* (Plate XX, fig. 20), *L. Elongata* (Plate II, fig. 15), *Teratomyces* (Plate X, figs. 6 and 11), *Compsomyces* (Plate XI, fig. 14), or *Stigmatomyces Baeri* (Plate I, fig. 26).

The disposition of the antheridia, and their relation to one another on the same appendage or branch, is a matter of much importance in affording generic distinctions, and even, in a few cases, is of service in defining species. On this basis all the genera having simple antheridia, with the exception of *Amorphomyces*, which has invariably a single antheridium, might be separated into two categories: those in which the antheridial cells are disposed in definite series on the appendage, and those in which they are more or less indefinitely placed.

In the first category are found forms in which the series is a single one, as in *Stigmatomyces* (Plates I, figs. 8-12; VIII, fig. 3), the antheridial cells succeeding one another in a single vertical row, while a somewhat more complicated condition exists in *Idiomyces*, where three vertical rows are present (Plate IX, figs. 18-19). Again,

in Helminthophana there are four rows symmetrically arranged (Plate VIII, fig. 10) on the single appendage. In all these cases the antheridial cells are themselves branchlets from the axis of the appendage. In Rhadinomyces and Corethromyces, however, the entire axis of the antheridial branch is formed from the superposed venters of the antheridial cells, the necks alone being free and projecting in a vertical row (Plate IX, figs. 5, 9, and 14).

In Teratomyces a somewhat similar condition is brought about through the repeated sympodial branching of the appendage, the false branchlets (Plate X, figs. 6 and 11) being either antheridia or short sterile outgrowths, terminated by a characteristic beak-like cell. Although, in this last instance, a regular series of antheridial cells, either alone or mingled with sterile branchlets, is produced, the type is not strictly comparable with that of the previously mentioned instances; in which the antheridial cells or branchlets originate as a result of the septation of an axis already formed and the production of monopodial branchlets from the resultant cells. In Teratomyces it is evident that the serial arrangement is necessitated by the relative position of the crowded appendages.

In the second category may be included all the remaining genera, comprising forms in all of which the simple antheridia are not thus disposed in regular series, but are more or less irregularly placed on the appendages. Although never serially arranged through monopodial branching, individual examples occur, however, in which the grouping of the antheridia is very characteristic and specifically distinctive. Among the instances included in this general category, Laboulbenia is by far the best illustration, since it comprises a greater variety of forms than any other genus. Among those in which there is no definite relation in position between the antheridia, *Laboulbenia elongata* or *L. Pterostichi* may be mentioned, while among forms in which there is a more definite grouping, *Laboulbenia variabilis* (Plate XXI, fig. 3) or *L. proliferans* (Plate XVII, fig. 23) offer the best examples of more or less regular and distinctly characteristic clusters. Species in which the antheridia are borne in pairs, or are irregularly grouped, are common; while in one instance, the curious *L. zanzibarina* (Plate XVII, fig. 3), a single short series may result, as in Teratomyces, from continued sympodial branching.

In regard to the number of simple antheridia that may occur in individual cases, it may be mentioned that there are often wide differences, not only between different species, but between individuals of the same species. *Laboulbenia texana*, for instance (Plate XX, figs. 16-18), has one, rarely two, antheridia, while *L. elongata* may have from five to fifty or more. Wherever fertilization has failed, as not infrequently hap-

pens, the production of antheridia is greatly increased (Plate II, fig. 8). Further reference to this circumstance will be made in connection with the "abnormal forms" described below.

Turning to the *compound type of antheridium* we find much less uniformity than in the simple type just described, although the antheridial cells which make up the essential portion of this organ are practically identical with the simple antheridium. As has been already mentioned, these cells seem to be intercalary in origin as far as can be determined in the absence of a knowledge of their early development, and instead of being wholly or partly free, both the necks and venters are closely united below, beside or around a common cavity into which they discharge. Of the twenty-seven genera thus far described, about one-third are characterized by possessing this compound type of antheridium, and since that occurring in *Dimeromyces* is one of the largest and most easily studied, it may be taken as an illustration. In this genus the species are dioecious, and the male individual reaches a maximum differentiation, being as well developed as the female, and bearing more than one antheridium (Plate IV, fig. 16), which possesses a stalk-cell and four basal cells lying below the antheridial cells. The antheridial cells in this case are six in number, symmetrically arranged in two rows, their venters large and emptying through long narrow canals into the somewhat inflated base of the long and slender "secondary" neck which serves as a common medium for the final discharge of the products of all the antheridial cells. The latter here correspond closely to those previously described in connection with the simple antheridia, and the formation from them of antherozoids is also similar in all respects. The canal, however, does not enlarge, as in the simple form, immediately after leaving the venter; but continues about the same diameter till it has nearly reached the general cavity at the base of the secondary neck, when it expands slightly. As a result, the antherozoids remain in connection with the protoplasm of the venter till they project some little distance into the cavity of the secondary neck, eventually separating from it and falling free into this general receptacle, whence, as represented in the figure, they may be seen at various points making their way out. The antheridium of *Dimorphomyces* is essentially identical with that just described, the male individual in this genus, however, producing but a single antheridium (Plate V, figs. 8-9 and 14-15). In *Peyritschella* (Plate II, fig. 12), *Dichomyces* and *Enarthromyces* (Plate III, fig. 19), although the antheridium is somewhat different in form, the secondary neck being less prominent and less abruptly distinguished, its general structure is also essentially the same; the four to six antheridial cells in the last mentioned genus lying somewhat obliquely side by

side in two rows, below a common cavity into which they empty. In these instances the antheridium has no stalk-cell, and is closely united to the receptacle. In *Camptomyces* and *Eucantharomyces* it terminates the appendage and is somewhat different in character. In *Camptomyces* the antheridial cells are placed around and beside a general cavity, and are arranged in several nearly vertical rows, emptying upwards through short necks into this cavity, whence they escape through the terminal pore of a short secondary neck (Plate VI, figs. 5 and 6). In *Eucantharomyces* the antheridial cells are also arranged in nearly vertical rows, and are more numerous than in the last mentioned genus. They empty into a general cavity, which is central and terminal, and are discharged through a well-developed, though somewhat irregular, secondary neck (Plate VII, fig. 27). In both these genera the material has been so limited in amount, and the antheridia are so difficult to observe by focussing through the asymmetrical arrangement of their numerous antheridial cells, that I have been unable to obtain a figure that would show satisfactorily the exact details of structure and arrangement presented by the latter. The gross structure is, however, made out without difficulty, and the general cavity is usually filled with very numerous antherozoids, which here and there may be seen in process of formation from the antheridial cells in a fashion exactly resembling that which occurs in the instances previously described.

A single type of compound antheridium remains to be mentioned, which occurs in *Haplomyces* and in *Cantharomyces*, and in this instance also, owing to the lack of sufficient material and to the complicated structure of the organ, much remains to be learned concerning its exact structure. The type is distinguished from those already mentioned from the fact that the secondary neck opens, as far as can be ascertained from the material available, through a lateral pore, and consists of a central cavity almost completely surrounded by the very numerous antheridial cells which open into it. This general structure may be made out by focussing through the organ; but no further details have been visible in the specimens examined. The antheridium (Plate VII, figs. 3, 9, and 22) is identical in the two genera mentioned, except that in *Haplomyces* it is terminated by a thorn-like cell, while in *Cantharomyces* it is placed below a well-developed sterile branching portion. With the exception of *Cantharomyces pusillus*, which may possibly prove to represent a new generic type, none of the species of these genera have been seen in a fresh condition, and they are the only ones possessing compound antheridia in which the discharge of the antherozoids has not been observed. The antheridium in these forms is the most highly developed that has thus far been noticed, and further observations upon it are greatly to be desired.

The antheridia are usually so placed that the antherozoids are discharged very near to, or even directly upon, the female organ when the latter is mature (Plate I, fig. 15; Plate II, fig. 2; Plate III, fig. 18). When they are associated with long and well-developed appendages, they are usually borne near the base of the latter (Plate II, fig. 5, anth.), and where also, as in the case of *Laboulbenia*, there are inner and outer appendages or branches, the male organs usually occur on the inner ones, that is, on those nearest to the female. There are, however, some exceptions to this rule in which the antheridia and trichogynes are not thus closely associated; as, for example, in *Teratomyces*, in which the former are borne some distance below the latter, and are curved away from them. In many cases also, though the two sexes may be closely associated, there is often a marked tendency in the male to turn away from rather than towards the female, as in *Stigmatomyces* and *Eucantharomyces*. In the dioecious genera, the male and female individuals are always in close proximity, their invariable association resulting from the fact that the spores always become attached to the host in pairs, corresponding to those which are formed in the ascus, and that, of any given spore pair, one member produces a male while the other produces a female (Plate V, figs. 2, 5, 17, 20, and 23). Notwithstanding the fact that the male and female organs are in general so closely associated, it is more than probable that cross-fertilization occurs quite as frequently, if not more frequently, than close fertilization; since not only are the species as a rule more or less gregarious in habit, but the maturation of the antherozoids invariably precedes that of the trichogyne, and the former continue to be produced long after the latter has been fertilized, in many cases after the perithecium has matured and begun to discharge its spores. This is true of forms having but a single perithecium; but more strikingly so in those which produce several successive perithecia. In *Dimorphomyces*, for example, the antheridium of the male individual continues to produce antherozoids indefinitely, while the female may produce two or even four sets of perithecia. The same extension of the functional period of the male is also seen in all the genera having compound antheridia. In forms having simple antheridia the same extension of functional activity in the male is often effected by the production of new antheridial cells or new fertile branches after the fertilization of the trichogyne.

As has been previously mentioned, the antherozoids are formed, in those genera which produce them exogenously, as lateral branchlets, the whole or portions of which become separated in the form of long slender rods (Plate XXIV, figs. 21, 24; Plate XXIII, figs. 21-23), having a definite cell wall, while in the genera producing them endogenously the contents of the venter of the antheridial cell are protruded through

the opening in the diaphragm into the cavity of the neck, and this protruded portion, having reached a definite size, becomes separated as a free mass of protoplasm, which, having been, as a rule, moulded to a cylindrical form in the cavity of the neck, makes its exit through the terminal pore. When free, the endogenous antherozoids exactly resemble bacilli or cocci in appearance, becoming rounded at the ends so that the short forms are almost spherical (Plate I, fig. 26; Plate VI, fig. 5; Plate II, fig. 2; Plate III, fig. 19). Their substance is refractive and homogeneous, and I have been unable, by staining, to differentiate a definite nucleus. Although, when first separated from the contents of the venter, they are undoubtedly naked protoplasmic masses, in some cases at least a thin wall seems to be secreted around them after their exit from the antheridial cell. In *Enarthromyces*, for example, which possesses antherozoids larger than those of any other known form, such a wall appears to be present, and the same may very probably be the case in other forms in which the antherozoids are so minute that exact observations in this respect are made with difficulty, even after they have become attached to the trichogyne. When freshly discharged they are usually sufficiently characteristic in appearance to be readily distinguished from the bacteria and yeasts which are often so numerous on certain individuals as to completely corticate the appendages.

The discharge of the antherozoids from the antheridial cell is a slow process, and probably does not occur more frequently than once every two or three hours; at least this is about the rate observed in individuals which have been separated from the host and placed in water. It may be, however, that the rate is more rapid under natural conditions; since the parasite does not survive very long after separation from the host, which doubtless disturbs not only its nutrition, but also its general turgescence. From the secondary neck of compound antheridia the discharge is, of course, often much more rapid at times, and a dozen or more antherozoids may be seen to make their exit within a few minutes after an individual of *Camptomyces*, for example, has been mounted in water. Cultures of the antherozoids in water, continued for many days, have never shown any indication of an attempt at development. Reference has already been made to the duration of the active period of the antheridia, and it remains to note the fact that the numbers of antherozoids formed during this period from a single antheridium must be counted by hundreds, or even thousands, in the case of the more highly-developed compound forms.

Female Sexual Organs. — It has been previously mentioned that in a majority of forms the antheridial appendage is developed from the terminal cell of the germinating spore. The female organs, however, are always formed from the products of

division of the basal cell, never in any case from the terminal cell, where this is present. Although the products of the division of the terminal cell are invariably sterile or male, it is not true, as might be supposed, that the basal cell or its derivatives have any inherent female character; since, in many cases, both normal and abnormal antheridia and antheridial branches may arise below the point of insertion of the female organ, or even, in exceptional cases, replace it entirely (Plate II, figs. 7-8). While, then, the primary appendage is, as a rule, terminal, the trichogyne, as well as the perithecium which follows it, are always lateral, with the single exception of *Amorphomyces*, where both are developed terminally from the unsegmented spore. This lateral origin is, however, very often obscured in the fully developed plant, from the fact that the perithecium, as it develops, is apt to push the appendage more or less to one side, and assume an apparently terminal position; as, for example, in the genus *Stigmatomyces* or in *Laboulbenia*.

We have already seen that the basal cell of the germinating spore begins its development by the formation of a cross partition which divides it into an upper and a lower cell, and that the base of the latter becomes modified to form the foot. The development of the upper, although varying considerably in the different genera, may, perhaps, be best illustrated by reference to the series of figures (Plate I, figs. 1-24) of *Stigmatomyces*, which is typical of the more simple forms. In this series, fig. 2 represents the spore after it has become attached to the host, the foot is beginning to form and the upper half is considerably enlarged. Figs. 3-5 illustrate the further development of the upper cell, the lower still remaining as at first. In fig. 6, the lower cell has become divided into two superposed cells, the upper of which (*b*) forms the basal cell of the appendage. The lower cell (*y*) then divides in two by a transverse partition, forming the basal cell and the sub-basal cell (*a*). This sequence of divisions is not apparently constant, and in other forms, at least, it more frequently happens that the partition which separates (*a*) from the basal cell is formed before that which separates (*a*) from (*b*). In fig. 7, the nucleus of cell (*a*) has already divided, although no wall has formed between the daughter nuclei. In fig. 8, this wall has been formed and the cell (*a*) has become divided into an upper and a lower cell (*a'* and *a''*), cell (*b*) remaining permanently without further division as the base of the appendage. Of these two cells (*a'* and *a''*), the lower remains without further change as the terminal cell of the receptacle; while the upper (*a'*) alone continues to develop into the female sexual organ and the perithecium. It will be noticed that even at as early a stage as is represented in fig. 8, the antheridial cells have begun to mature and to discharge their antherozoids. Cell (*a'*) next begins to grow upward and

outward (fig. 9), and by the formation of a septum is soon divided (fig. 10) into an upper and a lower cell (*d* and *c*). From the upper of these cells, which may be called the *primordial cell of the procarpe*, is formed the whole of the female sexual organ, while from the lower (*c*), which may be similarly called the *primordial cell of the perithecium*, are developed the cells which form the perithecium proper. This lower cell (*c*) is the first to show further signs of development, and becomes divided by a more or less obliquely longitudinal septum (fig. 11) into two cells (*c''* and *c'*). The cell (*c''*) then begins to grow upward, and becomes divided into an upper and a lower portion, fig. 12 (*z*) and (*p*). The lower cell (fig. 12, *p*) constitutes the "stalk-cell," while the upper continues to divide, as will be presently described. The cell (*c'*) of fig. 11, on the other hand, becomes separated into two upper cells (fig. 12, *i, i*), lying on opposite sides so that only one is shown in the figure, and a lower cell (*h*), which may be called the secondary stalk-cell. The cell (*z*) and the cells (*i, i*) then continue to grow up around the base of the cell (*d*), the primordial cell of the procarpe. One of the cells (*i, i*) then becomes separated into a single lower and two upper cells, while the other becomes separated into a single lower (figs. 13, *o*) and a single upper cell (*n*), as also does the cell (*z*); the cells (*o'*) and (*n*) of fig. 13, resulting from its divisions. There are thus formed three proper basal cells of the perithecium, two anterior (*o, o'*) and one posterior (*o'*), but two of which are shown in the optical section (fig. 13), and from them four cells are separated above which continue to grow upward and surround the cell (*d*), the base of which is now (fig. 13) completely enclosed and has become separated by a cross partition as the cell (*f*) from the part (*e*) which still remains free above it.

We then have this basal part (fig. 13) constituting a central cell (*f*), distinguished from the free part above (*e*) by a cross partition, and completely surrounded by the seven cells (*o, o'* and *n, n*), but four of which are, of course, shown in the optical section. The central cell (*f*) then remains without further development until fertilization has taken place; the terminal portion of cell (*e*) in the mean time becomes separated from the part below (fig. 14, *e''*) as a usually very small cell (*e'*), which immediately begins to produce a terminal outgrowth, the young trichogyne. This small cell is more marked in the genus illustrated than in most others in which it is not, as a rule, so clearly distinguished; the filamentous portion usually growing directly from the apex of cell (*e*), from which it is separated by a septum (Plate II, fig. 2). Cell (*e'*) and the projection (*tr*) from it must therefore be considered as constituting together the trichogyne proper. As the latter develops, the cell (*e'*) becomes less well marked, while the filamentous portion reaches a development that varies in

different specimens, but is usually not greater than is represented in fig. 15 (*tr*) and in fig. 16. Before fertilization it can be clearly seen, as in the last-mentioned figure, that the trichogyne and the basal cell (*c'*) constitute a single cell, and the nucleus is usually readily made out in the position indicated at the base of the trichogyne. Meantime the cells (*nn*) and (*oo'*) of fig. 13 have increased in size, and the former have begun to grow up still further around the base of cell (*e*), fig. 13, (*e''*), fig. 14.

With the maturity of the trichogyne the female organ has completed its development, and we have the condition represented in fig. 15, from which it will be seen that the latter, which may be conveniently termed the *procarpe*, consists of three distinct parts, which, so far as is known, are present in all genera of Laboulbeniaceæ. Of these the uppermost may be properly called the *trichogyne*, and in the present illustration is unicellular, though often, as will be seen presently, far more complicated in structure; the middle portion in this, as in all other instances, also unicellular, which we may call the *trichophoric cell* (*e'*), and the lowest portion (*f*), which may be termed the *carpogenic cell*, being that portion of the procarpe which is fertilized, and the only part which persists and undergoes further development. As is shown in the figure, the carpogenic cell is completely surrounded by eight cells, four of which (*oo*) lie below and around it, and, remaining undivided, form the basal cells of the mature perithecium; while the four others (*nn*) completely surrounded it, and, as will be seen later, form by further division the wall- and lip-cells of the perithecium. These eight cells are arranged in four longitudinal rows, and, in the stage represented, the upper four have already begun to grow up around the trichophoric cell, the lower half of which is now enclosed by their advancing tips. In the stage represented in fig. 15, the antherozoids, which have been continuously escaping from the antheridia since the stage represented in fig. 7 was reached, begin to adhere to the trichogyne, often in larger numbers than are represented in the figure, and fertilization is accomplished, probably with considerable rapidity if one may judge from the rarity of conditions which are intermediate between that represented in fig. 15 and that shown in fig. 19, where the trichogyne has entirely disappeared. In the comparatively infrequent instances in which one finds an adherent trichogyne belonging to a procarpe in which fertilization has evidently been accomplished, slight elevations may be seen which coincide with the position of usually more than one of the antherozoids (figs. 17 and 18). In such cases, although it is very difficult to determine the actual presence of conjugation in the case used for illustration, it is evident that a wall has been formed around the antherozoid, which often seems inflated and nearly empty of contents.

In brief, then, we find the female organ developed at first as a lateral outgrowth from one of the cells of the receptacle. From this outgrowth a terminal and a sub-terminal cell are cut off. From the former of these by further division is produced the procarpe, consisting of a terminal receptive portion, the trichogyne, a middle connecting portion, the trichophoric cell, and a lower essential portion, the carpogenic cell, which alone develops further; while from the latter arises by further division the whole of the perithecium proper. The subterminal cell thus forms the basal and wall-cells of the perithecium, while the terminal one, although at first quite free, forms its contents.

The further development of the young perithecium after the fertilization of the trichogyne may be also best illustrated by reference to the same series of figures of *Stigmatomyces* (Plate I, figs. 17–24). In fig. 17, which represents a condition in which fertilization has been completed, the procarpe remains unchanged, except that the carpogenic cell (*f*) has become somewhat enlarged and elongated. In fig. 18, the first indications of development are seen in the carpogenic cell, which, through the formation of two transverse partitions, has become divided into three superposed cells, while the trichogyne has begun to wither. As a rule, however, it has entirely disappeared when the first divisions of the carpogenic cell are visible. In fig. 19, this division of the carpogenic cell has become still more pronounced, and nothing remains of the trichogyne but its insertion. Disregarding the accompanying development of the wall-cells of the perithecium, and following only the divisions of the carpogenic cell, we may distinguish the three cells into which it first divides as follows: the lower of the three (*is*) may be termed the *inferior supporting cell*, while the upper constitutes the *superior supporting cell* (*ss*). The remaining cell, which lies between the two, may be conveniently termed the *ascogonium* (*am*), and is the only one of the three which undergoes any further development; the two supporting cells eventually disappearing entirely. Up to this point the development of the procarpe is similar in all the genera, so far as they are known; but the further divisions of the ascogonium show certain variations in different genera and even, apparently, in different specimens of the same species, although it is improbable that individual variations of this nature are at all common. In the present instance the ascogonium divides into a lower and an upper portion, the latter at the same time dividing, by somewhat irregularly longitudinal septa, into four cells. The lower portion (figs. 20–23, *ist*) remains unchanged, being eventually destroyed, like the two supporting cells (*ss* and *is*), and may be called the *secondary supporting cell*. We have then the ascogonium dividing simultaneously into five cells, one of them, the secondary supporting cell, remaining

sterile, while the others constitute the *ascogenic cells*, and at once begin to bud upward; the buds (fig. 21, *as*) developing into asci (fig. 22, *as*), and in this, as in a majority of cases, arising in a more or less distinctly double row. (See Plate I, fig. 38; Plate III, fig. 1; Plate V, fig. 18.)

In *Stigmatomyces* the four ascogenic cells, but two of which appear in the figures, are at first symmetrical neither in form, size, nor arrangement; but, as the asci begin to develop, become so placed that one is anterior, one posterior, and one lateral on either side. In fig. 23, which represents an antero-posterior view, the two lateral ascogenic cells are shown, placed more or less symmetrically with reference to one another, the anterior and posterior ascogenic cells (not shown in the optical section) occupying a similar relative position in front of and behind them.

Returning now to the perithecium proper, which we left in the condition represented in fig. 15, it will be remembered that it originated as a single cell (fig. 10, *c*), which has divided several times, and that the upper products of these divisions have grown up around the base of cell (*d*), from which, as we have seen, the female organ is developed. In this stage (fig. 15), it will be seen to consist of the stalk-cell (*p*), the secondary stalk-cell (*h*), and three basal cells (*o*), but two of which are visible in the figure, and four primary wall-cells (*n, n*), which surround the carpogonium (*f*) and the base of the trichophoric cell (*e''*). At a stage slightly earlier than that represented in fig. 15 a further development from the three basal cells takes place, which is not indicated in the optical section. This development consists in the upgrowth from the basal cells (*o*) of four cells corresponding to the wall-cells, but alternating with them and lying partly between them and the carpogonium. As they continue to grow upward and to increase in size, they separate the wall-cells completely from the structures developed from the carpogenic cell, growing up around the latter in a fashion exactly resembling that of the wall-cells. There are thus developed from the three basal cells, eight cells arranged in two series; an outer, the primary wall-cells, four in number; and an inner, also consisting of four cells. The further growth and the successive divisions of the cells of these two series, although its course is identical, is, nevertheless, quite independent in either case; the divisions of the cells of the inner series occurring in general after those of the outer series have taken place. The further development consists simply in a continued upward growth around the products of the division of the female organ, accompanied by the separation of a terminal portion. The latter is then again separated into two portions, the upper of which divides again, and so on, until the number of cells characteristic of the genus or species has been formed. This process may be made somewhat clearer by reference to figs.

17-20. In fig. 17, the primary wall-cells (fig. 15, n, n) have undergone their first division, having each separated into an upper and a lower cell (w and w'). The four cells of the inner series (n'') have also been developed from the three basal cells (o, o); but, although they extend upward above the septum which has divided the wall-cells, they are not themselves as yet septate. In fig. 18, the wall-cells remain as before, but each of the cells of the inner series has divided into two, ($p\ c$) the parietal cells and ($n\ c$) the primary canal-cells. In fig. 20 the primary canal-cells have again divided into two ($n\ c'$ and $n\ c''$), and this division has been preceded by a corresponding separation of the upper wall-cells (w, w) into the two cells ($w\ x$ and $w\ x'$). This condition continues until the asci have reached a considerable development (fig. 23); but before any of them are mature a last division takes place, by which the cell ($n\ c''$) of the same figure is separated into the cells ($c\ c$) and ($t\ c$) of fig. 24, and the cells ($w\ x'$) are separated into ($w\ y$) and ($w\ z$). In *Stigmatomyces*, then, there are present in the mature perithecium, before the spore discharge has commenced, an outer series of *wall-cells* disposed in four longitudinal rows of four cells each, the terminal cells of which may be conveniently called the *lip-cells*, and also an inner series of cells alternating with the outer, and also arranged in four longitudinal rows, each made up of four cells, the lower of which may be conveniently termed the *parietal cells*, the three others being distinguished as the *canal-cells*. There are thus four parietal cells, twelve canal-cells and sixteen wall-cells, making a total of thirty-two cells in the perithecium proper, exclusive of the three basal cells, the stalk-cell and the secondary stalk-cell previously alluded to (o, h , and p of fig. 15).

The asci, in the mean time, have continued to bud from the ascogenic cells, so that their total bulk has greatly increased, and as a result the ascus mass begins to exert a considerable pressure in all directions on the surrounding cells. In this way the superior supporting cell, the secondary inferior supporting cell, and the parietal cells are gradually destroyed, and in most instances, though not usually in that which has been used as an illustration, the inferior supporting cell is eventually obliterated by pressure. In *Stigmatomyces* the lower series of neck-cells (fig. 24, $n\ c'$) become gradually inflated towards their distal ends and their walls are somewhat thickened, so that they act as guard-cells which control, to some extent, the passage of the spores from the general cavity of the perithecium to that of the neck. The asci as they mature are sloughed off from the ascogenic cells, and rapidly disappear, their walls being absorbed as soon as the spores are completely formed, so that the latter lie free in the cavity of the perithecium. The spore mass thus formed, being constantly augmented, pushes between the guard-cells ($n\ c'$) just mentioned, and being forced still

further upward, destroys the two remaining series of canal-cells (*cc* and *tc*), and finally forcing their way between the lip-cells (*wz*) the spores make their exit through the permanent pore thus formed.

The special instance which has been selected as an illustration of the development of the female organ, although it may be considered typical of the process as it occurs in the family generally, does not, as has been noted, represent the invariable course of development in all cases, when the details of the successive changes are considered; and it will therefore be necessary to compare the processes described with the corresponding conditions presented by certain other genera.

The exact point of origin of the bud which is to develop into the perithecium, in so far as concerns its position with reference to the cells of the receptacle, is, as has been previously mentioned, subject to many variations in the different genera, although that which has just been described is the most common. The genus *Amorphomyces*, to which reference has several times been made, presents the most essential difference in this respect; since the terminal and subterminal cells of the germinating spore constitute the primordial cells of the procarpe and of the perithecium proper, respectively; the latter dividing and growing up around the former as in the case of *Stigmatomyces* just described (Plate V, fig. 23, *d, c*). In several other cases, as in *Rhadinomyces* and *Enarthromyces* (Plate III, figs. 13–18), the female organ first appears as a free bud, developed from a cell, not necessarily the sub-basal cell, of the receptacle; and this bud having become divided by a cross partition into two superposed cells, the same changes which have already been described in detail, take place in essentially the same way, as will be presently noted.

A very remarkable variation from the method above described by which the primordia of the perithecia and sexual organs arise from the receptacle, occurs in *Zodiomyces*; a genus in which these organs, instead of originating as superficial outgrowths, are formed as buds from a layer of cells which line the bottom of the cup-like extremity of the receptacle. This cup-shaped portion, though open at maturity, Plate XXIII, fig. 8, originates as a closed cavity below the base of the primary appendage, fig. 5, *x*, which becomes open as a result of the destruction of the superficial cells above it, which is effected by numerous sterile appendages that make their way out, fig. 6, *y*. The cells which give rise to the perithecia are thus primarily derived from the central parenchyma of the body of the receptacle. The course of development of the perithecia, in this instance, does not appear, however, to differ very materially from that already described.

Apart from these differences in origin, the development of the female organ corre-

sponds very closely in all the genera, up to the formation of the procarpe, with certain differences of detail; and in all cases the mature procarpe consists, as in *Stigmatomyces*, of the three essential parts above mentioned. The carpogenic and trichophoric cells are practically identical in all cases; but the trichogyne is subject to very considerable variations, even in the same genus. In its most simple form it is unicellular, as in the case of *Stigmatomyces*, without branches, and of no great length. Other unicellular trichogynes may be more or less branched, consisting of an abruptly enlarged portion from which radiate more or less irregular short lobes or branches, which are the receptive portions, sometimes quite numerous, as in the genera *Amorphomyces* and *Dinorphomyces* (Plate V, figs. 4, 5, 20, and 24), *Camptomyces* (Plate VI, fig. 4); and, to a less extent, in *Peyritsiella* and *Dichomyces*, both of which have trichogynes which are nearly simple or but slightly lobed (Plate VI, figs. 16 and 32). A similar trichogyne appears to be characteristic of *Dimeromyces* (Plate IV, fig. 17); but sufficient material is needed to determine this point.

The multicellular trichogynes, which are the more numerous, may be branched or simple, even in the same species, and sometimes reach a very remarkable degree of development; becoming many times septate and copiously branched, the free extremities being either straight or more or less definitely spirally twisted (Plate II, figs. 1-5, *tr*, and Plate XXI, fig. 15). The terminal portion of the trichogyne alone is receptive, and it is this part which is subject to the spiral twisting, the most striking instance of which occurs in the genus *Compsomyces* (Plate XI, figs. 9 and 10), well developed specimens of which, like that represented in fig. 9, producing more highly developed trichogynes than are found elsewhere in the family. In all cases the receptive tips have the same refractive appearance when mature that is noticeable in the corresponding organs of the Florideæ, and the continuity of the protoplasm of successive cells is readily demonstrated, as in other parts of the plant. However highly the trichogyne may be developed, it disappears with great rapidity as soon as fertilization has been accomplished, collapsing and breaking off, its point of insertion sometimes remaining as a scar-like prominence (Plate II, fig. 14, *tr*); while less frequently its base becomes somewhat indurated and persists even in the mature individual (Plate XXI, fig. 12 and Plate XVII, fig. 18). In a majority of cases, however, all signs of it have disappeared at an early stage in the development of perithecium after fertilization.

The process of fertilization, in so far as concerns the adherence of the antherozoids to the trichogyne, has been already referred to; the former in almost all cases being carried to the latter, whether they are discharged directly upon it or make their way to it by floating passively through the water, which, as we have seen, is apt in a

majority of instances to surround the individuals while their hosts are hiding in moist situations. The genera in which the antherozoids are exogenous in origin probably form an exception to this rule, and the transfer may be effected as above described (p. 210). At all events, the trichogyne in the genus *Zodiomyces* always grows downwards (Plate XXIII, fig. 16) as it develops and seems to seek the antherozoid which is almost invariably found attached to its tip (figs. 17, 18), and it is only after contact with the antherozoid that it turns upward as is shown in the two last-mentioned figures. In this instance several specimens have been examined in which there seemed to have been a definite conjugation between the two organs, as in fig. 17; but as a rule this union cannot be satisfactorily demonstrated owing to the very small size of the male element.

The fertilized trichogyne usually disappears before any definite change takes place in the other cells of the procarpe; but soon after this disappearance the divisions of the carpogenic cell already described succeed one another with considerable rapidity, and correspond at first in all the genera so far as they are known. The carpogenic cell divides by two transverse septa into three superposed cells, the superior and inferior supporting cells and the ascogonium; and the latter, at least in many of the instances observed, becomes separated into a lower sterile part which has been above described as the secondary inferior supporting cell; while the upper part either remains without further division, constituting the single ascogenic cell, as in *Amorphomyces*, *Sphaleroomyces*, *Peyritsiella* (Plate I, figs. 28, 29) and a few other genera; or becomes divided into two such cells, as in *Laboulbenia* (Plate I, fig. 35, *ac*) and in many other genera in which this is the usual number. Less frequently the number of ascogenic cells may be four, as in the case of *Stigmatomyces* above described; while in only one genus, *Haplomyces*, have *eight* such cells been definitely observed. Although the number of ascogenic cells is moderately constant in a given genus, it does not appear to be invariable, and I have seen rare instances in which two were present in forms having typically only one; while in a single instance a specimen of *Rhadinomyces* was observed in which three were distinct within the perithecium in place of the usual four; a condition doubtless due to the abortion of one of the original products of the division of the ascogonium.

The form of the ascogenic cell, though generally similar in most of the genera, is subject to certain variations, and the position which it occupies in the cavity of the perithecium is sometimes characteristic in given instances. In *Rhizomyces*, for example, it lies somewhat obliquely in relation to the axis of the perithecium, so that the ascus mass has the appearance represented in Plate III, fig. 3; while in *Chitonomyces*

paradoxus it is nearly horizontal, so that the asci growing inward, downward, and upward are much bent and distorted when mature. When they occur in pairs the ascogenic cells are more or less symmetrically arranged, and when there are but two, lie facing one another in a plane at right angles to that in which the perithecium is flattened. Where there are two or four pairs the perithecium is but slightly if at all flattened, and the ascogenic cells lie facing one another: one anterior, one posterior, and two lateral, or approximately so. The form of the ascogenic cell is subject to little variation, being, as a rule, oval in outline in face view; but in a few genera it is much elongated, as in *Amorphomyces*. (Plate IV, figs. 25–28), or *Sphaleromyces*, and in the former case may possibly become divided by a transverse septum in certain instances.

In *Stigmatomyces*, as has been mentioned, the asci bud from the ascogenic cell, alternating first from one side, then from the other; so that, as a result, two definite rows are formed, such as are illustrated in Plate IV, fig. 18, in Plate I, fig. 38 (at the left), and in Plate III, fig. 1, all of which represent dorsal views of the ascus mass, the ascogenic cell lying away from the observer and being consequently invisible. In the last mentioned figure, a slight irregularity is noticeable from the fact that an extra ascus has been abnormally produced at one point lying in the median line between the two rows normally formed. The most conspicuous exception to this biseriate arrangement of the asci is found in the genus *Moschomyces*, the very large ascogenic cell of which gives rise to an enormous number of asci arranged in many vertical rows; and, although such variations are exceptional, there seems in a few other cases to be some slight variation from the biseriate type.

The form of the ascus at maturity is subject to unimportant variations, being practically identical in nearly all the genera. It varies from a somewhat stout and short type (Plate VIII, fig. 28; Plate II, fig. 11; Plate I, fig. 25) to more slender forms (Plate XI, fig. 17 and Plate XXIV, fig. 9). At the time when the spores are fully formed, the ascus is commonly short-stalked; but as the latter begins to be pushed upward by the ever-increasing mass of asci below it, the basal part often becomes drawn out into a long slender pedicel, which finally sloughs off as the ascus wall itself begins to dissolve. In almost all cases the asci are four-spored at maturity, as in the majority of the figures cited, and are distinctly flattened, the only known exceptions to this rule being presented by the two genera, *Moschomyces* (Plate XI, fig. 17) and *Compsomyces*, in both of which they are definitely eight-spored and more nearly cylindrical. The asci are never naturally discharged from the perithecium, having wholly dissolved some time before they reach the terminal pore of the latter; but by

crushing perithecia in some aqueous stain like eosin, perfect asci in various stages of maturity are very easily obtained, either free or still attached to the ascogenic cell. Before they separate from their attachment, the asci are generally much distorted by mutual pressure, but assume a more or less regular form after they have become free.

As the ascus mass or masses increase in size, their upward pressure soon destroys the superior supporting cell, as we have already seen; while their downward pressure in most instances destroys the primary and secondary inferior supporting cells, at the same time freeing the ascogenic cells from one another, if there are more than one; so that the latter eventually lie in the cavity of the perithecium, free and unconnected with any other cells. In some cases the inferior supporting cell persists after the ascogenic cells have freed themselves from their attachments, as is the case to a certain extent in *Stigmatomyces*, the supporting cell in this instance being so placed as to be protected by the basal cells of the perithecium which surround it. In a similar manner the inferior supporting cell in the species of *Laboulbenia* allied to *L. palmella* persists permanently, for the reason that it is surrounded by the lower series of wall-cells of the perithecium, which are modified to form a perithecial stalk, and corticate it completely. The further destructive action of the ascus masses on the parietal and canal cells of the perithecium has already been described in connection with *Stigmatomyces*.

With the formation of the spores and the disappearance of the ascus-wall, the history of the female organ and its products is completed; but, as we have seen, the changes which it has undergone are accompanied by changes in the cells of the perithecium proper which are also subject to certain variations from the course of development described as characteristic of *Stigmatomyces*.

In all cases the perithecium proper, by which is meant all portions of it exclusive of the female organ and its products, originates as a single cell (Plate I, fig. 10, *c*; Plate III, fig. 14, *c*) that lies wholly below the terminal cell which gives origin to the female organ in the manner above described. This cell, which has already been alluded to as the primordial cell of the perithecium, divides, in cases which have been followed out and probably in most if not in all of the other genera, into two cells more or less obliquely superposed (Plate I, fig. 11, *c' c''*, and Plate III, fig. 15, *c', c''*); the divisions of which follow in general the same course which has been described in *Stigmatomyces*, and may be briefly recapitulated with reference to the genus *Enarthromyces*. Comparing figs. 15-17 of Plate III, which represent three successive stages of development, we have in fig. 15 the condition just referred to, in which the primordial cell of the perithecium (fig. 14, *c*) has divided into two obliquely superposed cells (*c'*) and (*c''*). In fig. 16 each of these has divided, (*c''*) into the stalk-

cell (p) and an upper cell (z); while the cell (c') has separated into a lower cell (h), the secondary stalk-cell, and two upper cells (i, i), only one of which is seen in the figure, the second lying opposite it on the reverse side. The two cells (i, i) and the cell (z) then continue to grow upward around the base of the primordial cell of the procarpe (d), and the cell (z) becomes separated into a lower cell (fig. 17, o'), the posterior basal cell, and an upper cell (n); while of the cells (i, i), one becomes separated into a lower (o) and one upper cell (n), the other into a lower (o) and two upper cells (n, n). The two cells (o, o) constitute the anterior basal cells, and thus, together with the posterior basal cell (o'), give rise to four cells (n, n), two only of which are seen in the optical section (fig. 17). The cells (n, n) in the figure cited have already grown up around the base of the primordial cell (d) of the procarpe, the base of which is completely enclosed, and is separated from the free portion above as a distinct cell (f), the carpogonium. In fig. 18, the cells (o, o') have also given rise to the inner series of perithecial cells which develop as in *Stigmatomyces*, and are eventually all destroyed.

The free part above has in the mean time developed a terminal trichogyne (tr), which is separated from the carpogonium by the trichophoric cell (e''). The four cells (n, n) then continue to grow upward, and their upper portion becomes separated by a septum. This upper portion then in turn divides into an upper and a lower part, and the process is repeated several times, until the number of wall-cells characteristic of the genus has been produced. During the formation of these wall-cells a corresponding development of the inner series of perithecial cells, fig. 18 (not shown in fig. 17), has taken place, resulting in the formation of the parietal and canal-cells previously described, which correspond in number to that of the wall-cells, and, like them, are derived as upgrowths from the three basal cells (o, o , and o').

The number of wall-cells which occur in a single row is usually four, as in *Laboulbenia* and many other genera, while in *Moschomyces*, *Compsomyces* and a few others, the number is five. As far as I am aware, the genus *Ceratomyces* (Plates XXIV and XXV) is the only one in which the number may not only vary in different species, but also in individuals of the same species. In this genus the perithecium attains in some instances a most extraordinary development, and in *C. rostratus* the number of wall-cells in a single row may reach seventy. These rows of wall-cells may be either straight, or spirally twisted, as in *Stigmatomyces Bacri*, or in some of the species of *Laboulbenia* (Plate XIV, fig. 27; Plate XX, fig. 19), and vary in specific cases both in form, relative size, and position. For example, in the genus *Laboulbenia*, the lower members of the series of wall-cells, as a rule, lie opposite the ascogenic

cells; but in some species they may lie wholly below them, being prolonged into a stalk, as in *L. longicollis*, *L. Kunkeli*, and their allies (Plate XIX, fig. 6, etc.; Plate XVIII, fig. 9). In such instances the ascus and spore masses, as they lie in the perithecium, are almost completely surrounded by the sub-basal cells of the series. In *Stigmatomyces Baeri*, on the other hand, the basal cells of the series occupy a corresponding position (Plate I, fig. 23), while in *S. virescens* (Plate VIII, fig. 2) the basal cells of the perithecium (not the wall-cells) extend up above the ascogenic cell and the base of the ascus mass. In a few cases the wall-cells may give rise to projections or definite appendages, which originate as lateral branches. Such a projection from one of the basal wall-cells is found in *Chitonomyces spinigerus* (Plate VIII, fig. 16). *C. appendiculatus* offers an example of a similar projection from one of the sub-basal cells; while instances of outgrowths from the terminal cells of the series are sometimes found, as in *Stigmatomyces virescens* (Plate VIII, fig. 1), *Laboulbenia Gyrinidarum* (Plate XXII, fig. 37), and a few other cases. In the genus *Ceratomyces*, multicellular appendages may be thus developed which may be even copiously branched (Plates XXIV and XXV); but in all the instances cited these structures are only of specific importance.

The terminal cells of the series of wall-cells have been already referred to as the "lip-cells"; since it is between them that the spores eventually force their way out from the perithecium. These lip-cells are often somewhat modified in shape, and are not, as a rule, similar and symmetrical, though sometimes so. They are usually modified to form a more or less elastic margin to the pore; as, for example, in some species of *Laboulbenia* (Plate II, fig. 14), the lip-cells of which are in general very irregular in form, and have their walls so modified as to give them great elasticity and thus regulate the discharge of spores. In this genus, and perhaps in some others, there is a peculiar structure at the apex of at least one of the lip-cells, represented in the figure just cited at (*x*), which may perhaps act as a valve, allowing the lip-cell, the cavity of which it terminates, to be more readily compressed, and at the same time to recover its form as soon as the pressure is removed. That the spore discharge may be regulated by modifications of cells other than the lip-cells has already been seen in the case of *Stigmatomyces* (Plate I, fig. 24); and in *Sphaleromyces* (Plate III, fig. 1), several sets of cells appear to assume this office. *Rhadinomyces* (Plate IX, fig. 13) affords an instance in which the lip-cells perform this function without any considerable modification.

Turning now for a moment to the inner series of cells which have been described as arising from the basal cells of the perithecium within, and alternating with, the wall-cells, we have seen that in *Stigmatomyces* their development follows that of

the wall-cells, although quite independent of it, and the same is in general true of all the genera. In forms in which, like *Ceratomyces*, the wall-cells become very numerous, a corresponding increase in the number of the canal-cells takes place; although the number formed may be fewer, as is indicated in Plate XXIV, fig. 8, which represents the growing apex of a perithecium in section, the divisions of the wall-cells (*w c*) being evidently more numerous than those of the canal-cells (*c c*). There seem, also, to be certain variations in the relative position of the canal-cells. In *Sphaleromyces*, for example (Plate III, fig. 2), the cells (*x*) are probably the lower canal-cells which have, by pushing between the wall-cells, assumed an apparently external position; and some similar modification of the more normal course of development may account for the peculiar arrangement of the cells at the tip of the perithecium in this genus, when seen antero-posteriorly as in fig. 1. It is not improbable that there are, in certain cases, variations of the course of development above described: yet in all the instances in which a careful examination has been made, it seems to correspond in all essentials.

While the wall-cells of the perithecium have a definite protective function, persisting and forming an envelope around the ascus and spore masses, and regulating and directing the dispersion of the spores; the inner series, as we have seen, performs an entirely different function which may well be compared, in so far as concerns the cells which I have called the parietal cells, to that of the so-called tapetal cells in the sporangia of the higher cryptogams; while the cells which I have called the canal-cells bear a similar resemblance in function to the neck-cells, for example, of an archegonium. It is needless to say, however, that there is not the slightest homology between the two structures in either case. The function then of the parietal cells is to make room for the developing ascus masses, and allow them to float free within the cavity of the perithecium; while that of the canal-cells is to afford a channel of exit by means of which the spores may make their way out through the pore of the perithecium. For, as we have seen in the case of *Stigmatomyces*, which is typical of the family generally, the growing ascus masses press upon and destroy not only their own connections with other cells above and below, but also the thin-walled parietal cells around them; while the mass of mature spores, which is constantly being pushed upward, has a similar effect upon the canal-cells, the latter, as a rule, having disappeared entirely when the spore discharge commences. In exceptional cases, as in that of *Stigmatomyces*, the walls of certain of the canal-cells (Plate I, fig. 24, *nc*) appear to become somewhat indurated, and to regulate, to some extent, the spore discharge; but I have observed no other instance than the one just mentioned, unless it be in the case of *Sphaleromyces* (Plate III, fig. 1) above alluded to.

It should be mentioned in this connection that in two genera (*Dimorphomyces* and *Dimeromyces*) not only do the parietal cells lose their individuality as cells, but also the basal cells of the perithecium, the stalk-cell, and the secondary stalk-cell; so that the cavity of the stalk-cell and that of the body of the perithecium are continuous when the latter is fully mature. In these cases, as in many other genera, the cavities of the lower wall-cells of the perithecium are gradually obliterated, as the spore mass increases; the terminal and subterminal wall-cells often being the only ones, in old individuals, in which the cell cavity can be made out.

Before leaving the subject of the derivation of the two series of cells which constitute the outer and inner portions of the body of the perithecium proper, and of their relation to the cells below, it must be confessed that my first impression concerning the origin of the inner series was that they arose from the primary wall-cells (Plate I, fig. 15, *n*), through the formation of longitudinal tangential septa, it being a matter of great difficulty to make out their exact position and relations at the earliest period of their development; and it was not till the protoplasmic connections of both the outer and inner series was observed with some exactness, in specimens of *Laboulbenia* the cells of which had been separated by treatment with potash, that the true condition of things suggested itself. These connections, in so far as they have been absolutely seen in given instances, are represented in figs. 16 to 18 of Plate II, which should be compared carefully with the account above given of the successive origin of the stalk-cell, the secondary stalk-cell, the basal cells, and the wall-cells; the lettering corresponding in general to that of the figures above cited on Plates I and III. In figs. 16–17 (Plate II), the parietal cells, as well as the inferior supporting cell below the ascogenic cells, had been destroyed, so that the protoplasmic connection with these cells had also disappeared; but in fig. 18, which represents a young individual, some of them were distinctly visible, and it was apparent that the inferior supporting cell (*is*), and the two anterior basal cells (*g*) and (*d*), were definitely connected with the secondary stalk-cell (*h*), and that the two visible parietal cells (*pc*) were similarly connected with the two anterior basal cells. A second preparation showed with equal distinctness that the posterior basal cell (*o'*) was similarly connected with one of the parietal cells. It was, however, impossible to determine which of the two anterior basal cells gave rise to two and which to one parietal cell; yet it is safe to assume that the same cell (*d*) which (fig. 17) gives origin to two wall-cells, is also connected with two parietal cells. In the preparation, as will be seen (fig. 18), three connections were visible from this cell: one of which was evidently with a parietal cell, another with the wall-cell (*f*), the third running beneath and connecting on the opposite side either with

a wall-cell or with a parietal cell. The fourth connection could not be distinctly made out, and may well have been broken by the crushing which was resorted to in order to separate the cells from one another. The connections of the basal cells with the wall-cells, as they are represented in figs. 16 and 17, are very readily demonstrated. It will be noticed that in fig. 17 a portion of the posterior basal cell (*o'*), as well as its connection with the wall-cell (*i*), is indicated through the anterior basal cell (*d*), the connections of which with *two* wall-cells (*e*) and (*f*) are very distinct. The connection of the basal cell (*g*), shown in fig. 16, is not visible in this instance.

Having considered these special cases and their modifications as far as they are at present known, it may not be superfluous, even at the risk of tedious repetition, briefly to summarize the general development of the perithecium and of the structures which it contains, since it involves matters of such considerable importance that a clear understanding of it is essential.

Summary of the development of the perithecium and of the female sexual organs. The perithecium arises as a lateral, rarely as a terminal organ, and consists at an early stage of two superposed cells: an upper, which is alone concerned in the formation of the female organ, and a lower, from which is developed the perithecium proper. The upper cell elongates by terminal growth, and is converted into the procarpe through the formation primarily of two cross partitions, by which it is separated into a lower portion, the carpogenic cell, always a single cell; a middle portion, the trichophoric cell, also always a single cell, and a terminal portion, the trichogyne, which may consist of a single cell, or, through the formation of cross partitions often accompanied by copious branching, of very numerous cells. The free extremities only, of the trichogyne, are receptive, and conjugate with the antherozoids which adhere to them. As a result of this union, the trichogyne soon withers and disappears, while the carpogenic cell undergoes a series of divisions. First, by the formation of two transverse septa, it is separated into three superposed cells: the upper and lower constituting the superior and inferior supporting cells, respectively, which undergo no further changes; while the middle cell of the three, known as the ascogonium, divides, by more or less oblique partitions, into from two to nine cells, one of which lies at the base of the others and is called the secondary inferior supporting cell; while the one, two, four, or eight remaining cells are known as the ascogenic cells. Each ascogenic cell then begins at once to produce asci, which bud from it downward outward and upward, and soon becomes quite free in the cavity of the perithecium; destroying, as a rule, both supporting cells, and eventually the remains of the trichophoric cell, as well as the cells of the perithecium proper (parietal and canal cells) which lie immediately about and above it.

The cells which make up the body of the perithecium proper, all arise, on the other hand, from the primordial cell of the perithecium, which lies wholly below that of the procarpe. Its first division, with a few possible exceptions, separates it into two more or less obliquely superposed cells. From each of these cells upgrowths arise; one from the lower and two from the upper, which still retains its protoplasmic connection with the primordial cell of the procarpe. The lower becomes separated from its single upgrowth, and constitutes the primary stalk-cell; while the upper is similarly separated from its two upgrowths and constitutes the secondary stalk-cell. There are thus two stalk-cells surmounted by three upgrowths which have become separated from them and form three distinct cells, that begin to grow up around the base of the primordial cell of the procarpe. The body of each of these cells constitutes one of the three basal cells of the perithecium. From these three cells then arise eight upgrowths, four of which are external, while the remaining four are included by them and form an inner series. As a result of continued terminal growth, accompanied by the formation of a variable number of septa by which the growing tip is successively separated from the portion below, an envelope is formed which completely encloses the female organ and its products: consisting of an outer series of cells arranged in four rows, each made up of a definite number of superposed cells, which constitute the wall-cells of the perithecium; and of an inner series of cells similarly arranged, the lowest members of which have been called the parietal cells, while those above them are termed the canal-cells. Of the two series, the outer forms the perithecial wall, the inner being destroyed, with unimportant exceptions, to make room for the ascus and spore masses, and to provide a channel through which the spores may pass to their point of exit between the apposed terminal, or lip-cells, of the outer series.

General Relations and Character of the Cells. We have already seen that the gelatinous membrane which surrounds the ripe spore persists, in the growing and in the mature plant, as a general envelope within which the cells undergo their independent divisions and modifications. This envelope, though thin, is tough and very impervious, resisting the action of reagents and staining fluids in a manner which greatly increases the difficulties associated with any attempt to observe the nuclear and other changes that take place in the cells within it. In some cases it may be separated without much difficulty, by treatment with potash, or even, when the specimen is dry, by the application of water; the action in either case resulting in the swelling of the outer layers of the cell walls and the bursting of the envelope, through which the cells themselves may protrude while still connected, as is represented in Plate III, figs. 10 and 11. In other cases the envelope appears to be more firmly and intimately con-

nected with the outer layers of the cell walls, and, though always readily demonstrated by crushing, is not affected by the application of potash.

The cells of the Laboulbeniaceæ, with the exception of those which lie within the wall-cells of the perithecium, and of the receptive portions of the trichogyne, are characterized by possessing thick walls that, when treated with potash, are readily seen to consist of a number of layers, the outer of which are less dense, and soon become swollen and gelatinous. In a majority of instances they do not seem to be connected with the general surrounding envelope by any special organs of attachment; but, in certain cases, the innermost layers of the cell wall give rise to fibrillæ which, passing through the outer layers, are attached to the inner surface of the envelope. The latter, in such instances, is usually more or less conspicuously punctate, especially in cases in which it is suffused with some dark color, as, for example, in the sub-basal cell of *Laboulbenia Oberthuri* (Plate XXII, fig. 39). It may be mentioned in passing that the suffusions, usually of black or brown, which characterize many of the species, appear to be for the most part, if not entirely, confined to the envelope; the cell walls within them being, in general, hyaline.

In some cases, however, this blackening involves at least the outer layers of the walls themselves, as, for example, in the ordinary "foot." The same is true also in cases where, for instance, the septum separating two cells is thus modified. This occurs very frequently in the appendages of *Laboulbenia* and other genera, the blackening extending inward so that it appears to form a disc with a central perforation corresponding to the passage through which the protoplasm of adjacent cells is continuous. These blackened septa were noticed by Berlese, and described in his account of *Laboulbenia armillaris* as "black discs or rings," the nature of which was not determined.

The fibrillæ just mentioned, which, in the normal cell wall when it is viewed in optical section, give rise to the appearance described by Istvanffi as being due to the presence of "pore-canals," are more or less twisted when freed by treatment with potash, and are characterized by the presence here and there of granular thickenings (Plate III, figs. 11 and 12), their extremities being attached to the inner surface of the general envelope in a fashion that varies in different instances. In *Laboulbenia Kunkeli*, for example (Plate XVIII, fig. 9), they are characteristically attached in short rows, running transversely in the sub-basal cell, but less regularly disposed in the cells above it. In other cases they may adhere in more compact groups, as in *L. Nebriæ*, or singly without any definite and characteristic aggregation. These points of attachment tend to become dark-colored, especially in areas where the envelope itself

is suffused, and give to the latter the punctate appearance peculiar to many species. The presence of these fibrillæ has not been definitely determined in genera other than *Laboulbenia*, and even in this case, although so conspicuous in many species, they do not seem to be of invariable occurrence.

The substance of the cell walls as well as of the general envelope give, when treated with iodine and sulphuric acid, or with Schultze's chloriodide of zinc solution, no blue color.

The contents of the cells, especially those of the receptacle, are usually more or less characteristic while the plant is alive, and consist of rather dense granular protoplasm, in which, as a rule, certain highly refractive spherical oily masses are conspicuous. In some instances these masses are few in number, one or more of them being often very large (Plate V, figs. 4 and 5), while again they may be more numerous and uniform in size, completely filling the cells, as in the case of *Laboulbenia Harpali*, *L. Philonthi*, and many others. In general, however, they are more or less variable in size, and present the appearance indicated in fig. 15, Plate II. In glycerine they soon become indistinguishable, and are thus not represented in the accompanying figures, which were drawn, with few exceptions, from glycerine preparations.

The protoplasm of adjacent cells, the origin of which is the same, is connected by a conspicuous strand of the same substance, which passes from one cell to the other through a well marked perforation of the cell wall, the connection being demonstrated with great ease by treatment with potash and subsequent staining (Plate III, figs. 11–12; Plate II, figs. 16–18). In many instances, also, it may be seen in the living plant without the use of reagents. This protoplasmic connection is found in all the cells, including those of the trichogyne, when this organ is multicellular. In many cases in which the cells had been separated by potash, and the connecting protoplasmic strand stretched between them, I have seen a slight enlargement like that indicated in fig. 12, Plate III, recalling the similar structure through which the strands of protoplasm pass in the *Florideæ*. I have, however, been as yet unable to determine its exact nature.

A single, usually large, nucleus is found in the contents of every cell, and is often readily seen without the use of reagents; while in other cases it is by no means easy to demonstrate, owing to the difficulty which is usually experienced in staining the cell contents. The nuclei are spherical or nearly so, and usually contain a large nucleolus (Plate V, figs. 20 and 24; Plate I, figs. 7, 15, 16; Plate II, figs. 3 and 13). The nuclear changes accompanying cell division have not been determined; but from the occurrence of conditions like that represented in fig. 7, Plate I, it would appear

that the nucleus divides, and that the two resultant nuclei separate before the wall is formed between them.

Although a considerable amount of time has been expended in an endeavor to determine the nature of the nuclear changes which take place in the female organ during and after fertilization, I do not as yet feel in a position to make any definite statement concerning them, and have not ventured to give any drawings of the often-conflicting phenomena observed. Any one having an opportunity to study an unlimited series of specimens of *Stigmatomyces Baeri*, for example, in a fresh condition, would probably meet with no great difficulty in determining these matters; since from the considerable size of this species, its densely gregarious habit, and the nature of its trichogyne, it is peculiarly well adapted for this purpose. Of all the Laboulbeniaceæ none, however, is better suited for study in these respects than the form described below as *Enarthromyces indicus*, by reason of its large size and great simplicity; but, as a rule, observations of this nature are made with the greatest difficulty, owing chiefly to the lack of unlimited material in the proper condition of development and the impervious character of the envelope, which so seriously interferes with the action of stains.

Abnormal Morphology and Development. In examining a large body of material, cases are often met with in which the course of development, usually characteristic of a given species, is modified in various ways, and some of these modifications are sufficiently curious to call for mention in this connection. Among the simpler instances, abnormal septation in individuals of the cells, for example, of the receptacle, frequently occur in genera like Laboulbenia, in which the latter consists, with few exceptions, of an invariable number of cells. Such an instance is represented in fig. 9, Plate XX, the basal and sub-basal cells being thus divided, while in some cases a much more complicated cell division has been observed.

An abnormal production of branches in the appendages, due, as a rule, to breakage and subsequent renewal, is very common, especially in species in which the latter are more or less filamentous, and result in an irregularity of form and branching which does not occur in normally developed plants. The multiplication of appendages, normally single or definite in number, sometimes occurs, however, not as a result of injury; as in *Stigmatomyces*, the normally single appendage of which is rarely furcate near the base, each branch becoming a functional appendage.

The same is true in regard to the production of accessory perithecia. While in many forms more than one is usually produced, in a majority of genera it is typically solitary. In the latter class, however, instances are sometimes met with of the produc-

tion of accessory perithecia. This abnormal condition has been seen several times in the genus *Ceratomyces* (Plate XXV, fig. 7), and occurs also in *Chaetomyces*, *Corethromyces*, *Stigmatomyces*, and a few others. In *Rhachomyces* is found the most frequent and remarkable instance of this nature, the accessory perithecia arising in this instance in two distinct ways. In the one case, two may occur side by side as is represented in Plate X, fig. 22, or, through the proliferation of the receptacle below the base of the perithecium first formed, a second may arise a short distance above it (Plate XII, fig. 2). The same process may even be repeated, so that two or even three accessory perithecia may succeed one another, as in fig. 14 of the same plate. In the last mentioned cases the proliferation, usually, if not invariably, follows the abortion of the perithecia first formed, the trichogynes of which have, for some reason, failed to become fertilized.

One further instance of the abnormal occurrence of perithecia may be mentioned which has several times been noticed in the genus *Peyritschiella*. In all but one of the known species of this genus, the receptacle is terminated by a single perithecium (Plate VI) which may exceptionally be replaced by two. In the species referred to (*P. geminata*, Plate VI, fig. 7), the receptacle usually bears a terminal pair of perithecia. When, however, the individuals have grown under rather unfavorable conditions, as, for instance, near the extremities of the anterior pair of legs of their host, the lower transverse cell rows of the receptacle may give rise externally to several additional perithecia, which develop normally with the others.

To a similar failure of fertilization is also to be attributed the usually marked increase in the production of antheridia in such cases, which has been previously noted. Such antheridia are, as a rule, formed normally on the appendages; but in certain instances, on the other hand, this increase is effected by an abnormal process, as a result of which, accessory antheridial branches take the place of the perithecium, growing from the cells at its base (Plate II, fig. 8). In some cases the branches produced under these circumstances may grow up through and within the atrophied perithecium, emerging between its terminal cells, as is represented in Plate II, fig. 9. A condition similar to this is figured by Peyritsch (1873, Plate II, fig. 11), the protruding filament having been mistaken by him for a trichogyne. A specimen in which a similar growth from within the base of the perithecium has resulted in the production of large numbers of branches is represented in Plate II, fig. 10. In this instance the abnormal growth had apparently followed an injury, by which the upper half of a normally matured perithecium had been destroyed. Such examples well illustrate the fact that the cell series of the perithecium proper are merely eight modified, but independent, filaments

which under abnormal conditions may be replaced by or associated with typically filamentous growths similarly derived from the basal cells.

In very rare instances individuals are met with in which a typical antheridial appendage, in a normally bisexual form, is substituted for the female organ, the substitution being accompanied by a great increase in the number of antheridia produced. An abnormal male individual of this kind is represented in Plate II, fig. 7, the two appendages being in general normal even to the formation of the blackened insertion cells.

We have seen that in general the spores are discharged in pairs, and that, as a rule, and sometimes invariably, they adhere to the host and develop side by side. It is an interesting fact which may possibly have some bearing on the derivation of the dioecious from the monoecious forms, that in certain instances one member of the spore pair may normally, or not infrequently, become atrophied, or produce a smaller and weaker individual than the other. In the case of *Laboulbenia inflata* the atrophy of one of the spores, after it has reached an inconsiderable development, seems to be an invariable rule, as far as I have had an opportunity for observation, and groups of this species, when detached with a portion of the integument on which they are growing, show the condition of things represented in fig. 5, Plate III, the atrophy being apparent even at an early stage.

Normal Variations. Like other groups of plants, the Laboulbeniaceæ are subject to normal variations in form, size, color, etc., which are partly inherent and partly due to the action of external causes. In individuals growing under identical conditions, the variations are comparatively slight, and are expressed by inconsiderable differences in gross size, or variations in the relative development of different parts, often coupled with differences in color, which are, however, in general, due to the varying age of individuals. Forms, for instance, which, when young, even when they are sufficiently advanced to discharge their spores, are hyaline or pale straw-color, may become, as their age increases, dark amber-brown or suffused, wholly or in part, with blackish or smoky-brown shades.

Among the external causes which influence variation, the most important are associated with the character of the host, its size, and the position in which the parasite grows upon it. The color of the host, for example, often influences that of the parasite, the same species being sometimes very dark or nearly opaque on hosts with a dark or black integument, while they are pellucid, or nearly hyaline, on hosts of a lighter color, such differences in color being independent of differences in the age of the individuals in question.

Variations in size among different specimens of a given species are often influenced by two factors, namely, the size of the host and the position in which the parasite has become attached. Thus small specimens of a given species of insect will, as a rule, bear smaller parasites than larger ones, and the same is true of smaller species in a varied genus, for example, like *Platynus*, almost all the members of which are liable to be infested by a single species of *Laboulbenia*. In regard to differences dependent on the position of growth, it is usually true that individuals growing near the circulatory centres of the host, being presumably better nourished, are commonly distinctly larger. The largest individuals that I have observed, for example, have been found growing on the thorax or prothorax about the base of the two anterior pairs of legs, while, on the same insect, those which inhabit the tips of the elytra, or of the legs, include the smallest specimens. It should also be observed that individuals growing in situations in which they are exposed to the most unfavorable conditions are apt to be thick-set, short, and stout, with short appendages. This is true, for example, in specimens of *Laboulbenia elongata*, *L. subterranea*, and various other species, when they occur, as they not infrequently do, on the mouth parts or near the tips of the legs of their hosts, the difference in general habit in such cases being often so great that such forms might easily be mistaken for distinct species. The same short, stout habit, it may be mentioned, characterizes species which are found normally in such situations and not elsewhere; as, for instance, in the case of *Laboulbenia parvula*, *Peyritschella minima*, and others, that are, as a rule, found near the extremities of the legs, and only exceptionally in other situations.

The *rate of growth* of the Laboulbeniaceæ and the *duration of their life period* are matters concerning which it is not easy to make exact observations, owing, on the one hand, to the difficulty of obtaining freshly hatched hosts that have not been exposed to infection, and, on the other, to the uncertainties connected with the determination of the exact time at which the infection of the fresh hosts is accomplished. By keeping in confinement insects which have been collected with spores upon them just germinating and distributed on definite areas, one may estimate with considerable accuracy the time necessary for the fungus to reach maturity. This period, in the species of *Laboulbenia* which I have thus cultivated, has proved to be from two to three weeks. It is doubtless variable, however, in different genera; those which are more complicated in structure requiring, for their full development, a period correspondingly longer; as may well be the case, for instance, in *Rhachomyces* or *Zodiomyces*. According to Peyritsch, freshly hatched flies confined with others infested by *Stigmatomyces Baeri* were found to bear mature individuals of the fungus in from ten to four-

teen days, according to the temperature at which they were kept; and it is certainly improbable that many forms attain maturity in a much shorter period than this.

In regard to the *longevity* of individuals, it seems quite certain that those which have been mature in the autumn, may still produce spores during the spring and early summer; for although mature specimens which have hibernated are apt to be much damaged, and are often no longer fertile, fully mature individuals, evidently of considerable age, from their dark color, have been found on hosts still hibernating and collected by "sifting" early in the spring before the advent of warm weather. That the germinating spores and young individuals live over winter, attached to their hosts, in a dormant condition, is an undoubted fact; and it is upon the survival of these, rather than on that of the maturer individuals, that the fungus depends for its perpetuation. That a majority of forms, occurring in temperate climates, live throughout the summer and early autumn cannot be doubted; since one very rarely finds individuals that are old and infertile. When such cases occur, with few exceptions (as in *Amorphomyces*), the cessation of fertility has evidently resulted from some violent injury which has destroyed the perithecium, or a portion of it. From my own observations in this connection, I think that it may be safely assumed that, in a majority of cases, the life period of the parasite coincides with that of the host. The number of spores formed by a single individual must therefore be often enormous, in view of the fact that the ascogenic cells are continuously active during the growing season.

GEOGRAPHICAL DISTRIBUTION. Any intelligent discussion of the distribution of the Laboulbeniaceæ is hardly possible, since it is in North America only that their systematic study may properly be said to have commenced; yet, judging from the small number of exotic hosts which have been available for examination in connection with the preparation of the present monograph, it may be inferred that the warmer portions of the earth are quite as rich in representatives of the group as are the more temperate regions, while towards the colder northern latitudes they become distinctly less abundant. For, although specimens have been examined from localities as far north as Hudson's Bay and the Aleutian Islands, a comparatively small percentage of the hosts collected in these regions appear to be infested, while the reverse is true as the southern portion of the United States is approached. Notwithstanding the fact that the Carabidæ and Staphylinidæ, families of beetles which furnish by far the majority of the hosts at present known, are relatively much less abundant in tropical than they are in temperate regions, it seems highly probable that, in such localities, these orders are replaced by numerous other insects having suitable life-conditions, among which

orders other than Coleoptera are doubtless largely represented. This is indicated by the fact that two among the small number of tropical forms at present known occur on such peculiar and unusual hosts as those of *Laboulbenia armillaris* and *L. Hageni*, the one a mite, the other a white ant. Southern California also furnishes an instance of the occurrence of a peculiar form on a host, *Chilocorus*, quite unrelated to any of the usual genera of insects thus parasitized, and it must be remembered that the Diptera have hardly been examined at all in this respect. It thus seems not improbable, in view of the above facts, and of the more favorable conditions for development and perpetuation which exist in the warmer regions of the earth, that we may look to them for a large, if not the largest, future addition to the group; for that the family is destined to be greatly augmented can hardly be doubted.

Including a small number of forms not enumerated in the succeeding pages, from lack of proper material for description, the total number of Laboulbeniaceæ known at present to exist includes one hundred and fifty-eight species, from which five perhaps might well be deducted as synonyms, distributed among thirty genera, three of which are undescribed. Of these one hundred and thirteen are, so far as known, confined to North America, eleven to Europe, eight to Africa, three each to Asia and South America, including Panama, while two are peculiar to Australia. On the other hand, nine are common to North America and Europe; two to North and South America; one to North America, Europe, Asia, and probably to Africa; one, the determination of which is perhaps doubtful, to North America, South America and Africa, including Madagascar; one to South America and Africa; one to North America, Europe and probably to Asia; and, lastly, one to Africa and Asia (Japan).

Turning to the genera, one finds that of the twenty-five which are known in North America, twenty are not recorded from other continents; that of the six genera known in Europe, two have not been found elsewhere; that of four genera known from Africa, two are indigenous; while of the two Asiatic genera, one is confined to that continent. Lastly, South America and Australia are each known to possess but the single genus *Laboulbenia*, which is universally distributed.

It is needless to remark that these statistics have little or no value as showing the actual relative distribution of the species and genera in the several continents, and they are merely given to indicate the possibilities of distribution in so far as our imperfect knowledge will permit. For convenience of reference a table giving in more detail the facts of relative distribution outlined above is here appended:—

Total number of species known to exist	158
“ “ “ “ described	152
“ “ “ North American species described	124
“ “ “ North American species known	130
“ “ “ European species	19
“ “ “ African species	14
“ “ “ South American species	6
“ “ “ Asiatic species	6
“ “ “ Australian species	2

Common to North America and Europe. — *Chitonomyces paradoxus*, *Rhadinomyces pallidus*, *Laboulbenia elongata*, *L. cristata*, *L. Gyrinidarum*, *L. luxurians*, *L. Nebriæ*, *L. subterranea*, *L. vulgaris*.

Common to North America and South America. — *Laboulbenia Guerinii*, *L. variabilis*, *L. polyphaga*.

Common to North America and Africa. — *Laboulbenia Catascopi*, *L. polyphaga*, *L. elongata* (?).

Common to South America and Africa. — *Laboulbenia Pheropsophi*, *L. polyphaga*.

Common to Africa and Asia (Japan). — *Laboulbenia proliferans*.

Common to North America, South America, and Africa. — *L. polyphaga*.

Common to North America, Africa, Europe, and Asia. — *Laboulbenia elongata*.

Common to North America, Europe, and Asia (?). — *Laboulbenia vulgaris*.

In regard to the distribution of single species in a given continent no data are available in any case except that of North America, where a wide distribution of given species is indicated. The common *Laboulbenia Nebriæ*, which is also known to occur in Europe, is found in America from Maine to Virginia, and west to Washington, extending northward to Alaska and the Aleutian islands. *Laboulbenia cristata* is another instance of a European form which is found in this country from Maine to Nicaragua, and several examples might be mentioned of species found throughout the United States and Mexico. The writer has unfortunately had no opportunity of collecting Laboulbeniaceæ on their living hosts outside of New England, and it is only in this limited territory that an approximate knowledge of their local distribution has been obtained; yet in general it may be safely assumed that the different species have a range practically coincident with that of their usual hosts. The occurrence of more or less cosmopolitan forms, like some of those mentioned above, which are doubtless more numerous than our present knowledge would indicate, has a certain interest when we consider that the possibilities of dissemination are so restricted as is necessarily the case where, as in the present instance, direct transfer from one living host to another is an essential factor in the perpetuation of the species. Of the more local occurrence of the Laboulbeniaceæ nothing further need be said at present, since, as has just been mentioned, it coincides with that of the special hosts of the group, which will be presently referred to.

HOSTS OF LABOULBENIACEÆ. According to our present knowledge all members of the family are entomogenous, and occur only upon members of the orders Coleoptera, Diptera, and Neuroptera, with a single instance found among the Arachnida. Peyritsch in his third paper refers to an observation recorded by Hagen, where he does not state, of the occurrence of a member of the family on one of the Orthoptera; and although this must be considered of doubtful authenticity, it seems more than probable that others of the insect orders, especially the Hymenoptera, may prove to be similarly parasitized. It will be noticed in the appended host index that coleopterous hosts outnumber very greatly all others; yet it should be borne in mind that this predominance of beetles in the list may be due in part to the fact that no other group has been examined with any care in this connection. The known occurrence of species on such diverse insects as the delicate fly *Drosophila*, the larva of a white ant, and the acarid *Antennophorus*, certainly suggests many possibilities as to the types of hosts likely to be affected. There seems no good reason, then, why a much greater variety of insects than are at present known should not be added to the list, especially from the tropics, provided that they fulfil the apparent requirement of overlapping generations and moderate longevity, coupled with a cleanly and not too solitary habit.

The relative numbers infesting the various orders and families of insects may be seen at a glance from the following table, which includes all forms known to the writer, whether described or otherwise, and is approximately correct, though not absolutely so, in so far as regards the number of the undetermined species of hosts.

TABLE OF HOST INSECTS OF LABOULBENIACEÆ.

Total number of species of insects known to become the hosts of members of the Laboulbeniaceæ	250
Total number of genera represented by these hosts	86
Total number of hosts belonging to the order Coleoptera	241
Total numbers of hosts in the different families of this order: —	
Carabidæ	genera 47; species, 156
Haliplidæ	“ 2; “ 2
Dytiscidæ	“ 3; “ 8
Gyrinidæ	“ 3; “ 15
Hydrophilidæ	“ 4; “ 9
Staphylinidæ	“ 18; “ 50
Coccinellidæ	“ 1; “ 1
Total number of hosts belonging to the order Diptera	6

Total numbers of hosts in the different families of this order:—

Nycteribidæ	genera, 3; species, 3
Diopsidæ	“ 1; “ 1
Drosophilidæ	“ 1; “ 2
Muscidæ	“ 1; “ 1

Total number of hosts belonging to the order Neuroptera 1

A single family Termitæ genus, 1; species, 1

Total number of hosts belonging to the order Arachnida 1

A single family Gasimidæ genus, 1; species, 1

In comparing the species and genera represented by these hosts it is noticeable that although the Carabidæ exceed all other families as regards the number of genera and of species, both of hosts and parasites, the number of genera by which they are infested is comparatively small. Of the seventy-five species of Laboulbeniaceæ which are found on members of this family, sixty-five belong to the single genus *Laboulbenia*, while the remaining ten are distributed among but five genera, *Dimeromyces*, *Peyritschella*, *Enarthromyces*, and *Rhachomyces*. In the case of the Staphylinidæ, however, which, next to the Carabidæ, includes more hosts than any other family, the proportions in this respect are quite different. For although the genus *Laboulbenia* predominates to such a degree in the Carabidæ and infests all of the orders, and a majority of the families given in the above table; among the fifty species known on members of the Staphylinidæ, but four belong to this genus, while the remaining forty-two are distributed among no less than eighteen genera. The last mentioned family is thus by far the most interesting in this connection, and its parasites abound in peculiar forms.

It is further observable that the aquatic hosts, with the exception of the Gyrinidæ, the species of which swim on the surface of the water and carry their hosts at least partly exposed to the air during much of their existence, are infested only by members of the three genera *Zodiomyces*, *Ceratomyces*, *Hydraemyces*, and *Chitonomyces*, of which the two first mentioned are the only representatives of the group of “exogenæ,” producing their antherozoids exogenously.

In general, it is true that among the Coleoptera infested a majority are either riparian or aquatic in their habits; yet there are a number of forms that occur upon insects which live away from the water and often inhabit rather dry situations. Of these, *Chilocorus* is perhaps the best example; while, outside the Coleoptera, the common house-fly affords a conspicuous instance of a host very subject to this parasitism, yet far from riparian in its habit. Peyritsch notes the fact that, in his experience,

hosts inhabiting the margins of running water were much more likely to be parasitized than those found along the borders of ponds or of still water generally; but this has certainly not been my own experience, and the margins of ponds or of boggy places generally have always proved as rich in Laboulbeniaceæ as those of brooks or rivers. It is also worthy of note that the statement made by the same author that iridescent hosts are not infected has not proved to be true in my experience.

The relation of the parasite to its host as regards its nutrition has already been referred to, and there can be no doubt that the fluids of the insect are absorbed by osmosis through the membrane of the foot or haustorium, whether this be a highly developed penetrating organ, as in *Rhizomyces* or *Moschomyces*, or consists merely in a sucker-like external attachment.

The relation of the parasite to its host, in position, is a matter of interest for several reasons; for, although all parts of the latter may be infested, the antennæ, the eyes, the mouth parts, the anal plates, — in fact any portion exposed when the insect is at rest, — certain species exhibit a very remarkable definiteness in regard to their point of attachment. In some forms, like *Laboulbenia Nebriæ*, or *L. Galeritæ*, the parasite occurs indiscriminately all over the host; others, like *L. terminalis*, *L. fumosa*, or *L. luxurians*, only at the tips of the elytra and the adjacent region about the extremity of the abdomen. Others, like *L. parvula* and *L. arcuata*, have been found only on the legs, the latter species always in a definite position. *L. Harpali*, again, occurs on one side only, along the anterior inferior margin of the thorax and the adjacent margin of the prothorax. *L. contorta*, *L. umbonata*, *L. elegans*, *L. lepida* and *L. texana* all occur, with very rare exceptions, on the prothorax just below the external margin, usually on a definite side; and it may be noted in passing that, especially as regards the extremity of the perithecium, all the last-mentioned species have a family resemblance. Instances like those just enumerated might be multiplied; but by far the most remarkable examples occur in the genus *Chitonomyces*. Species of this genus growing, for example, on *Laccophilus maculosus*, can be distinguished, as a rule, with certainty merely by noting their relative positions. *C. paradoxus* is invariably fixed to the margin of the left elytron about half-way between its base and apex; *C. marginatus* occurs just within the margin of the same elytron nearer the apex. *C. lichanophorus* is found only on one of the inferior median anal plates (always the same plate), and so on through the list of twelve species that infest this host; the only instance which I have noticed of any deviation in their position being in the case of *C. marginatus*, which is rarely found attached to the left posterior leg.

Why such constancy in position should exist in some cases, and not in others, is a

matter that I am wholly unable to explain. It is certainly not connected in any way with matters of nutrition, and although it may be in part explained as resulting from the fact that the spores are transferred while the sexes are *in coitu*, and the points of infection are determined by definitely recurring motions of the legs or otherwise, this does not seem sufficient to explain the constancy of the phenomenon. Peyritsch (1875), calls attention to the fact that *Stigmatomyces Baeri* invariably occurs on the under surface of the male and on the upper surface of the female host. Such a fact, if it were true, would readily be explained in this way. My own observations, however, do not agree with those of Peyritsch in this respect, though this relative position may perhaps be the more common.

That certain types of form are associated with certain types of hosts seems to be a fact illustrated in a limited number of instances, — a well-marked case being afforded by the species of *Laboulbenia* which are found on *Clivina* and its near allies, and those which occur on *Galerita* and related forms. The species of *Laboulbenia* which inhabit water beetles also furnish a case in point.

Parasites of Laboulbeniaceæ. In examining a very large amount of material I have been struck by the general absence of parasites attacking these fungi. A very small number of such parasites do, however, occur, the most striking of which belong to two forms of an apparently new genus of the Chytridineæ, which grow externally on species of *Ceratomyces*, possessing well-developed filaments and large appendiculate zoosporangia. The only other parasite which seems at all peculiar to the order is a minute organism, perhaps a yeast, that often completely envelopes the appendages, especially of species of *Laboulbenia*, assuming a characteristic semi-lunar form. The same organism sometimes makes its way into the interior of the perithecium, filling it and destroying its contents.

Parasites associated with the Laboulbeniaceæ, and, like them, attached to living insects, are more or less abundant; and while the majority are animal in nature (bell animalcules, rotifers, etc.), there is one genus of fungi (?), unknown to me, which, though quite colorless, resembles some of the more simple chlorozoosporic algæ. It is attached to the insect (and sometimes by accident to specimens of the Laboulbeniaceæ) by a slightly blackened base, and consists of about three superposed cells, the upper of which produces a small number of apparently non-motile spores endogenously, that escape through a terminal opening.

The genus described as *Devoea*,¹ which is evidently not in any way “related to

¹ Lockwood, S. Fungi affecting fishes. Jour. N. Y. Microscop. Soc. Vol. VI., p. 67 (1890).

the Saprolegniæ," but seems to be an encysted condition of some protozoan or other animal organism, is also not infrequently found on water beetles.

The collection of *Laboulbeniaceæ* involves little more than the collection of a sufficient number of the proper hosts, although their presence on the latter is not always easy to ascertain in case of the smaller forms. In so far as concerns the collection of hosts, my own experience, which is not that of a skilled entomologist, much less of a coleopterist, indicates that the most favorable localities in which to search for infested beetles is along the margins of small streams or of ponds. In such situations abundance of hosts may usually be found under stones or sticks, or in rubbish, that may be best shaken over a sheet or other white cloth, on which the insects are readily captured. Traps deposited in such situations, and made by raking together a heap of decaying grass, algæ, etc., often yield large numbers of interesting specimens when examined in this way. Many forms may also be obtained by leaving bundles of hay or grass in cultivated ground for a few days and examining them over a sheet. Water beetles are in general best obtained by sweeping the margins of ponds or ditches with a dip net; those bearing *Zodiomyces* occurring in cool gravel along the margins of brooks, or in cold, wet rubbish which has accumulated on rocks or branches in its bed. Staphylinidæ which are either mycophagous or finicolous have not been found to yield any parasites. Forms of this family most likely to be infested are best obtained by using the two kinds of traps above mentioned. The collection of hibernating specimens by "sifting" seldom yield parasites in good condition. A few hosts may be obtained on flowers: *Harpalus pennsylvanicus*, for example, which is very commonly infested, is usually found in abundance climbing up the spikes of *Ambrosia artemisiæ-folia* about dusk.

Laboulbeniaceæ may be "cultivated" in the manner above alluded to, by confining infested hosts with such as are free from any parasites; and this is not a matter of any considerable difficulty, provided that surroundings are furnished which are suited to the habits of the insects employed. If pains are taken to keep these surroundings moist and fresh, the parasites will develop normally; but if there is not sufficient moisture to allow of a certain amount of condensation on the surface of the hosts, fertilization is apt to be interfered with, and, as a result, one finds a large number of abnormal and undeveloped forms. As a rule, it is more satisfactory and quite as little trouble to obtain specimens that have grown under natural conditions, and little, if any, advantage is to be obtained from such artificial cultivation.

No attempt has been made to cultivate the spores in artificial nutrient media, and the results which might be looked for from such cultures, even if they should prove

to be possible, which I very much doubt, are not likely to afford data which could not be as well or better observed by the examination of successive stages in individuals naturally developed; except, perhaps, in so far as concerns the possibilities of monstrous development which these plants might exhibit under such unnatural conditions.

Preparation of Material for Examination. Having obtained a number of hosts which are liable to be parasitized, it will found that from about five to fifty per cent. will bear parasites. In order to obtain them for examination, the host should be killed and impaled on a fine needle (a No. 12 sewing-needle mounted in a match is the most convenient), care being taken that the surface of the insect remains perfectly clean and dry, and then examined over a dull white, and then over a black surface with a hand lens magnifying about eight or ten diameters, a dissecting microscope being most conveniently used for this manipulation. Every portion of the insect should be examined in different positions, and when the parasites have been discovered, they should be removed by means of a dissecting needle like that just mentioned, the needle having been inserted in the match far enough to give it the requisite stiffness, while its apex should have been ground on a fine oil-stone until a sharp, slightly oblique chisel point has been obtained. With such a point, the individuals are scraped off without much difficulty, and should be transferred to a very small drop of water on the slide. When the desired number have been thus transferred, the individuals may be conveniently arranged by means of a fine hair mounted like the needles. The excess of water should then be drawn away from the specimens with a shred of blotting paper, and as soon as the moisture has dried around them, they should be quickly treated with alcohol, and covered with a cover glass which should always be supported by a shred of blotting paper or a chip of cover glass. The alcohol should then be replaced by water, as quickly as possible, when the individuals will be found still living, if the manipulations have been sufficiently rapid, and attached to the surface of the slide as a result of the slight drying just mentioned. Although these directions may seem superfluous, it will be found that if they are accurately followed, much trouble and the loss of many specimens will be avoided. For permanent mounting, I have used only glycerine, to which is best added a small amount of a saturated alcoholic solution of eosin, together with a trace of common salt. This preparation is very satisfactory for general purposes, and should be allowed to run under the cover glass and replace the water slowly, as it evaporates. If the replacement is too rapid, the individuals will become shrunken, but generally regain their normal form in a few days, or in a much shorter time.

Dried material for herbarium specimens, which is always sufficiently good for

purposes of determination, should be mounted in tight pill-boxes on the herbarium sheet, to avoid the depredations of *Anthrenus* and other pests of insect collections. A little cotton in the box prevents the host, as well as its parasites, from being injured by falling about when moved. Care should also be taken that the insect is kept clean and free from dust particles or exudations from its own body. Otherwise, it is often difficult or indeed impossible to detect the parasites when needed for examination.

PART II.

NOTE CONCERNING THE SYSTEMATIC POSITION OF THE LABOULBENIACEÆ.

THE systematic position of the Laboulbeniaceæ has been a matter of much uncertainty, and even in the light of a fuller knowledge, both of the forms and of their development, it still remains undetermined what are their immediate connections within the group of Ascomycetes to which they must undoubtedly be referred. As we have seen, Montagne and Robin (1853), who were the first to describe them as plants, speak of the single genus then known as "*e familia Pyrenomycetum novum genus*," and compare it to *Capnodium*, although they made no observations on the origin of the spores. Later, Karsten, who first included them in the *Mucorini* (1869), places them (1895) in a group of "*Stigmatomycetes*," between the *Ustilagineæ* and the *Pyrenomycetes*; but although this author correctly observed the essential fact of the occurrence of fecundation, he denies the presence of asci, and gives a quite erroneous account of the spore formation. Peyritsch (1871, 1873), although his observations on the process of fecundation were incorrect, was the first to present any definite evidence of their ascomycetous nature; yet it seems doubtful whether asci were seen even by him, since his reference to them as "*eight to twelve spored*" indicates the correctness of the criticism made by Karsten, who held that these "*asci*" were merely the ordinary aggregations of spores, coherent in a fusiform mass, as is their wont, and surrounded by their own gelatinous envelopes, which were mistaken for the ascus wall. This element of uncertainty in the observations of Peyritsch led De Bary to place the group among his "*Doubtful Ascomycetes*," a disposition in which he has been followed by most systematists who have alluded to the group at all. In any case, it is at present definitely determined that asci, containing four or very rarely eight spores, always occur; and that they are beyond question the morphological equivalents of the corresponding structures in the Ascomycetes generally. It further seems undeniable that these bodies are of sexual origin, in view of the evidence adduced in the foregoing pages. If, then, we admit both the sexual and the ascomycetous nature of these plants, their consideration becomes a very important factor

in any attempt to trace the homologies of the ascus or the derivation of the group of Ascomycetes in general.

It is not my intention in this connection to enter into any detailed discussion of the several theories which have been advanced in regard to these matters; yet they cannot be allowed to pass unnoticed. In brief, it may be said that, as regards the primary origin of the Ascomycetes, authorities seem generally agreed in deriving them, in an ascending series, from the Phycomycetes; but in the discussion of the homologies of the reproductive organs in either case, the agreement has not been so striking. De Bary, as is well known, relying in a great measure on his observations in regard to the development of *Sphærotheca*, as well as on the account given by Eidam of his genus *Eremascus*, finds little difficulty in homologizing (with his usual judicious cautiousness of statement) the asci of these genera with the oogonia of the Phycomycetes; while their sexual derivation was further substantiated through the studies of Janczewski and others on *Ascobolus*, by those of Kihlman and others on *Pyronema*, by those of Stahl on the Collemaceæ, as well as by further observations which need not be here enumerated. In later years there has been a reaction from this view, for the most part due to the very important, yet unconvincing, researches of Brefeld. This writer, by the accumulation of a large amount of wholly negative evidence, having discarded as without significance the positive evidence just referred to, presents an argument from which he concludes that although the Ascomycetes have originated from the Phycomycetes, they have lost all traces of sexual organs. According to this view, the ascus is assumed to be merely a modified non-sexual sporangium, homologous with the non-sexual sporangia of the Phycomycetes; and an attempt is made to substantiate this assumption by the citation of a series of examples which, in his opinion, illustrate the actual process of evolution by which this transformation has been brought about.

In still more recent years, observations made by Dangéard on the phenomena of nuclear fusion in the Ascomycetes and elsewhere, prior to spore formation, have led this writer to believe that oosporic sexuality, thus expressed, is general among the higher fungi, including the group in question; a view which, for reasons that need not here be considered, does not seem to call for serious consideration.

It is thus apparent that the question under discussion has resolved itself into the phyllogeny, not of the Ascomycetes, but of the ascus; one "school" asserting its non-sexual character, the other the reverse. Supporters of the former contention, like Van Tieghem, for example, seeing in the trichogyne of Stahl a remarkably developed "ventilating apparatus," or in the "carpogonium" of *Ascobolus* or *Pyronema*, a

group of merely vegetative cells charged with nutriment destined for a special purpose. Others, again, believing that the organs described are sexually significant, consider them, in many cases, functional, while in others, they may have lost their sexual character or have disappeared entirely; the presence among the Ascomycetes of purely apogamic forms being as readily reconciled with the coexistence of sexual forms as it is among the Phycomycetes, where a similar degeneration to an apogamous condition is well known to exist in not a few instances.

Recent investigations, however, embodied in the very important paper on *Sphærotheca* lately published by Dr. Harper,¹ indicate that while De Bary, who may be considered the chief exponent of the view last mentioned, was correct in his general observation as to the existence of sexual reproduction in connection with the formation of the ascus in this plant, he was misled by his failure to observe the very significant phenomena exhibited by the changes which take place in the carpogenic cell after its fertilization. These phenomena, which consist in the production of a series of superposed cells only one of which, and that not the terminal one, enlarges or buds out to form the solitary ascus, forbid any such direct comparison as that suggested by De Bary, between this single ascus and the oogonium of the Phycomycetes. It seems not unlikely that further and more exact observations on *Eremascus* may lead to some similar modification of the course of development described by Eidam; and in any case, in view of the absence in one or in both of these instances of such evidence as they were thought by De Bary to afford in support of his own views, and the, to myself at least, wholly unconvincing character of the arguments and illustrations presented by Brefeld in support of his peculiar theories, one seems justified in suggesting at least the possibility of an origin for the Ascomycetes quite different from that assumed by either of these authorities. In my own opinion, the comparison made by Harper, in the paper cited, between the sexual process therein described and that of *Nemalion*, though it might seem at first sight hardly warrantable, becomes distinctly justified when one places between these two instances that of the present group.

If, on the one hand, we compare the Laboulbeniaceæ with the Florideæ, a very distinct agreement is apparent between them as regards their mode of growth and general structure; while this comparison is also suggested by the gelatinous envelope and the conspicuously developed continuity of the protoplasm between adjacent cells within it. The development of the perithecia in the one case finds a parallel in that of certain cystocarps, and the type of sexual reproduction in either group is essentially identical.

¹ Ber. d. Deutsch. Bot. Gesell., Vol. XIII, p. 475 (1895).

If, on the other hand, the group is compared with the ascomycetous fungi, one finds that the differences in general structure are apparent and not real, the vegetative body consisting of a septate filament which elongates and branches in a definite fashion within a general enveloping membrane. The thallus is thus not essentially different in the two cases, and the perithecium of the Laboulbeniaceæ is exactly comparable to the corresponding structure in other Ascomycetes, like *Sphærotheca* for example; the process of formation in either case involving the enclosure of a female cell, through the upgrowth around it of filaments originating below its base. It is further unquestionably true that its sexual organs and sexual reproduction are strictly homologous with the corresponding structures and phenomena that have been described in the Collemaceæ, in *Ascobolus*, in *Sphærotheca*, and in other instances. Lastly, the products resulting from this sexual process, the asci and ascospores, are identical and homologous with those similarly resulting in the cases mentioned.

That the Laboulbeniaceæ greatly resemble the Florideæ may then be inferred from the general structure of its members, its sexual phenomena, and the development of its sporocarps and asci, resemblances which, it may be added, are coupled with an aquatic or sub-aquatic habit. That it belongs not among the algæ, but among the fungi, is indicated by the absence of chlorophyl and of true cellulose in its cells, coupled with a parasitic habit; while the products of its sexual reproduction, the asci and ascospores, are those of fungi and by no means of algæ.

In view of these facts the derivation of the Ascomycetes through the Laboulbeniaceæ from some branch of the Florideæ seems a supposition not unworthy consideration, and although personally I regard such a suggestion as a mere speculation, I must confess that if one must have a theory of derivation in this case on a basis of ascertained facts, an origin of the nature above indicated is in my own opinion more probable as well as more logical than that which is usually held: since the latter involves the, to my mind, improbable assumption that a parasitically degraded series has attained, by a parallel course of upward development, the same goal which has been reached by the carposporic algæ; the alternative, on the other hand, involving the consideration of the fungi as a heterogeneous group derived through degeneration at different points from types already elaborated in the algal series.

Speculations of this nature are, however, of little value in the absence of facts by which they may be substantiated; yet if the origin of the family from the Florideæ is, to say the least, problematical, it is almost equally a matter of conjecture if one attempts to determine their exact point of union with the Ascomycetes in general. While their color, gelatinous consistency, and entomogenous habit might suggest a

remote relationship to the Hypocreaceæ, it is worthy of note that the bodies most nearly resembling the characteristic antheridial cells found in the family are the "Hyphopodies mucronées" of the Meliolæ; but having as yet been unable to examine the latter in a fresh condition, I can at present merely suggest the possibility of a similarity of function.

In arranging the genera under which are grouped the species included in the following systematic enumeration, the primary divisions have been based on the characters of the male sexual organs. Forms having antherozoids exogenously produced, have been separated in a group of "exogenæ," comprising but two genera, while the remaining twenty-six genera having antherozoids that are produced endogenously, are placed in a second group of "endogenæ."

The two genera of the first-mentioned group are both primarily aquatic, and if we entertain the suggestion that the family has been derived from carposporic algal ancestors, might, from their simple antheridial branches and their aquatic habit, be considered as probably the more primitive of the two groups. Of this group, the genus *Ceratomyces* may be taken as the type, since it illustrates most clearly not only the exogenous formation of antherozoids, but the indeterminate development of the perithecia and their tendency towards an appendiculate condition.

The twenty-four genera of the second group offer many difficulties, if one attempts to arrange them in lineal sequence; but here again the character of the male sexual organs affords a natural means for their general separation into two groups, characterized in the one case by the presence of what have been previously described as "compound," in the other of "simple" antheridia, and these again may be subdivided according as the sexual organs occur on the same or on different individuals.

A further subdivision has been employed in the following synopsis based upon the determinate or indeterminate arrangement of the antheridial cells; but this disposition, while it expresses, in a measure, true relationships, by bringing together such genera as *Idiomyces*, *Stigmatomyces*, and *Helminthophana*, is not wholly satisfactory. Further than this, a definite arrangement into not too numerous sub-groups is hardly possible, although it is evident that genera like *Moschomyces*, *Compsomyces*, and perhaps *Sphaleromyces*, or *Teratomyces* and *Diplomyces* should go together. A more definite appreciation of their further relationships will no doubt become possible after the discovery of additional genera; but at present it would be quite superfluous to attempt to represent them graphically.

GENERAL SYNOPSIS OF THE GENERA AND SPECIES WITH THEIR HOSTS.

FAMILY LABOULBENIACEÆ.

GROUP I. Endogenæ. Antherozoids produced endogenously.

ORDER I. PEYRITSCHIELLEÆ. Antheridial cells united to form a compound antheridium.

A. Diœcious.

GENUS I. DIMORPHOMYCES. Perithecia and appendages borne in pairs to the right and left of the median line.

(1) *D. denticulatus* Thaxter, on *Falagria dissecta* Er., N. America.

(2) *D. muticus* Thaxter, on *Falagria dissecta* Er., N. America.

GENUS II. DIMEROMYCES. Perithecia and appendages in a unilateral series.

(1) *D. africanus* Thaxter, on *Pachyteles luteus* Hope, Africa.

B. Monœcious.

* Antheridium borne on an appendage free from the receptacle.

GENUS III. CANTHAROMYCES. Antheridium lateral below a terminal branch of the appendage. Perithecia free.

(1) *C. Bledii* Thaxter, on *Bledius assimilis*, N. America.

(2) *C. occidentalis* Thaxter, on *Bledius armatus* Er., N. America.

(3) *C. pusillus* Thaxter, on *Trogophlæus* sp., N. America.

GENUS IV. HAPLOMYCES. Antheridium terminal tipped by a spine-like process. Perithecia free.

(1) *H. californicus* Thaxter, on *Bledius ornatus* Lec., N. America.

(2) *H. texanus* Thaxter, on *Bledius rubiginosus* Er., N. America.

(3) *H. virginianus* Thaxter, on *Bledius emarginatus* Say, N. America.

GENUS V. EUCANTHAROMYCES. Antheridia terminal with a neck-like terminal canal, the antheridial cells in five (?) vertical series. Perithecia free.

(1) *E. Atrani* Thaxter, on *Atraneus pubescens* Dej., N. America.

GENUS VI. CAMPTOMYCES. Antheridium terminal with a prominent apical pore. Antheridial cells in two (?) vertical series. Perithecia free.

(1) *C. melanopus* Thaxter, on *Sunius prolixus* Er., *S. longiusculus* Mann., N. America.

** Antheridium sessile on the body of the receptacle, sharply pointed.

GENUS VII. ENARTHROMYCES. Receptacle a single series of superposed cells with one or more lateral antheridia. Perithecia free.

(1) *E. indicus* Thaxter, on *Pheropsophus* sp., Asia.

GENUS VIII. PEYRITSCHIELLA. Asymmetrical receptacle consisting of several superposed transverse series of cells above its one or two basal cells; antheridium single, lateral. Perithecia free.

- (1) *P. curvata* Thaxter, on *Platynus cincticollis* Say, N. America.
- (2) *P. minima* Thaxter, on *Platynus cincticollis* Say, N. America.
- (3) *P. geminata* Thaxter, on *Pterostichus luctuosus* Dej., *P. patruelis* Dej., *P. erythropus* Dej., N. America.
- (4) *P. nigrescens* Thaxter, on *Philonthus debilis* Grav., N. America.

GENUS IX. DICHOMYCES. Symmetrical receptacle of several superposed transverse series of cells, the basal cell single; a pair of antheridia on the subterminal series. Perithecia free.

- (1) *D. furciferus* Thaxter, on *Philonthus debilis* Grav., N. America.
- (2) *D. inæqualis* Thaxter, on *Philonthus debilis* Grav., N. America.
- (3) *D. infectus* Thaxter, on *Xantholinus obsidianus* Melsh., N. America.
- (4) *D. princeps* Thaxter, on *Philonthus sordidus* Grav., N. America.

GENUS X. HYDRÆOMYCES. Receptacle asymmetrical, its distal portion united to the perithecium; its three basal cells superposed. Aquatic.

- (1) *H. Halpli* Thaxter, on *Haliphus ruficollis* De G., *Cnemidotus muticus* Lec., N. America.

GENUS XI. CHITONOMYCES. Receptacle asymmetrical, its distal portion united to the perithecium; its two basal cells superposed. Aquatic.

- (1) *C. paradoxus* (Peyritsch), on *Laccophilus maculosus* Germ., *Laccophilus* sp. indet., N. America; *L. hyalinus* Dej., *L. minutus* Sturm., Europe.
- (2) *C. appendiculatus* Thaxter, on *Laccophilus maculosus* Germ., N. America.
- (3) *C. distortus* Thaxter, on *Laccophilus maculosus* Germ., N. America.
- (4) *C. spinigerus* Thaxter, on *Laccophilus maculosus* Germ., N. America.
- (5) *C. uncigerus* Thaxter, on *Laccophilus maculosus* Germ., N. America.
- (6) *C. melanurus* Peyritsch, on *Laccophilus hyalinus* Dej., *L. minutus* Sturm., Europe.
- (7) *C. marginatus* Thaxter, on *Laccophilus maculosus* Germ., *Laccophilus* sp. indet., *Hydroporus spurius* Lec., N. America.
- (8) *C. rhyncostoma* Thaxter, on *Hydroporus spurius* Lec., *Laccophilus maculosus* Germ., N. America.
- (9) *C. lichanophorus* Thaxter, on *Laccophilus maculosus* Germ., N. America.
- (10) *C. uncinatus* Thaxter, on *Laccophilus maculosus* Germ., *Hydroporus spurius* Lec., N. America.
- (11) *C. affinis* Thaxter, on *Laccophilus maculosus* Germ., *Hydroporus* sp., N. America.
- (12) *C. hyalinus* Thaxter, on *Laccophilus maculosus* Germ., N. America.
- (13) *C. simplex* Thaxter, on *Laccophilus maculosus* Germ., *Hydroporus spurius* Lec., and sp. indet., N. America.
- (14) *C. Bidessarius* Thaxter, on *Bidessus granarius* Aube, N. America.
- (15) *C. borealis* Thaxter, on *Desmopachria convexa* Aube, N. America.
- (16) *C. aurantiacus* Thaxter, on *Desmopachria convexa* Aube, N. America.

ORDER II. Laboulbeniæ. Antheridial cells distinct, discharging independently.

A. Diœcious.

GENUS I. AMORPHOMYCES.

(1) **A. Falagriæ** Thaxter, on *Falagria dissecta* Er., N. America.

(2) **A. floridanus** Thaxter (species pro tem.) on *Bledius basalis* Lec., N. America.

B. Monœcious.

* Antheridia borne in definite series on the appendages.

x. Antheridia springing directly from successive cells of the appendage.

GENUS II. HELMINTHOPHANA. Appendage solitary, bearing the antheridia in four vertical series.

(1) **H. Nycteribiæ** Peyritsch, on *Megistopoda Westwoodii* Kolen., *Acrocholidia Montaguei* Kolen., and *Nycteribia Dufourii*, Europe.

GENUS III. STIGMATOMYCES. Appendage solitary, bearing the antheridia in a single vertical series.

(1) **S. entomophila** (Peck), on *Drosophila nigricornis* Loew., N. America, *Drosophila funebris* L., Europe.

(2) **S. Baeri** Peyritsch, on *Musca domestica* L., Europe.

(3) **S. virescens** Thaxter, on *Chilocorus bivulnerus* Muls., N. America.

GENUS IV. IDIOMYCES. Appendages numerous, bearing the antheridia in three vertical series.

(1) **I. Peyritschii** Thaxter, on *Deleaster dichrous* Grav., Europe.

xx. Antheridia borne on branches of the appendages.

GENUS V. CORETHROMYCES. Appendages forming a tuft, the antheridial cells superposed and forming lateral branchlets.

(1) **C. Cryptobii** Thaxter, on *Cryptobium pallipes* Grav., *C. bicolor* Grav., N. America.

(2) **C. setigerus** Thaxter, on *Lathrobium nitidulum* Lec., N. America.

(3) **C. jacobinus** Thaxter, on *Lathrobium jacobinum* Lec., and *L. collare* Er.

GENUS VI. RHADINOMYCES. Appendage single with terminal sterile branchlets; antheridia superposed in short series forming branchlets near its base.

(1) **R. cristatus** Thaxter, on *Lathrobium nitidulum* Lec., *L. punctulatum* Lec., N. America.

(2) **R. pallidus** Thaxter, on *Lathrobium fulvipenne* Grav., *L. punctulatum* Lec., *L. angulare* Lec., N. America.

** Antheridia not arranged in definite series on the appendages.

GENUS VII. RHIZOMYCES. Basal cell of the receptacle penetrating the host by rhizoidal outgrowths; sub-basal cell giving rise to a single simple appendage bearing unilaterally a single series of branches, the basal cells of which bear antheridia.

(1) **R. ctenophorus** Thaxter, on *Diopsis thoracica* Westw., Africa.

GENUS VIII. LABOULBENIA. Multicellular receptacle formed in part by the union of the base of the appendage and the stalk-cells of the perithecium. Appendages arising beside the perithecium usually from a black insertion cell.

(1) **L. anceps** Peyritsch, on *Platynus viduus* Pz., Europe.

(2) **L. arcuata** Thaxter, on *Harpalus pennsylvanicus* De G., N. America.

(3) **L. armillaris** Berlese, on *Antennophorus caput-carabis*, S. America.

- (4) **L. Aspidoglossæ** Thaxter, on *Aspidoglossa subangulata* Chaud., N. America.
- (5) **L. australiensis** Thaxter, on *Acrogenys hirsuta* Maclean, Australia.
- (6) **L. Brachini** Thaxter, on *Brachinus mexicanus* Dej. and spp. indet., N. America.
- (7) **L. brachiata** Thaxter, on *Patrobis longicornis* Say, *P. tenuis* Say, N. America.
- (8) **L. Casnoniæ** Thaxter, on *Casnonia pennsylvanica* Linn., N. America.
- (9) **L. Catascopi** Thaxter, on *Catascopus guatemalensis* Bates, N. America; *Catascopus* two spp., Africa.
- (10) **L. Clivina** Thaxter, on *Clivina dentifemorata* Putz., *C. dentipes* Dej., N. America.
- (11) **L. compacta** Thaxter, on *Bembidium* spp. indet., N. America.
- (12) **L. compressa** Thaxter, on *Anisodactylus baltimorensis* Say, N. America.
- (13) **L. conferta** Thaxter, on *Harpalus pennsylvanicus* De G., N. America.
- (14) **L. confusa** Thaxter, on *Bembidium* sp. indet., N. America.
- (15) **L. contorta** Thaxter, on *Platynus extensicollis* Say, *P. affinis* Kirby, N. America.
- (16) **L. cornuta** Thaxter, on *Bembidium complanulum* Mann., N. America.
- (17) **L. Coptoderæ** Thaxter, on *Coptodera Championi*, Bates, N. America.
- (18) **L. cristata** Thaxter, on *Pæderus littorarius* Grav., *P. obliterated* Lec., *Pæderus* sp. indet., N. America; *P. ruficollis* Fabr., Europe.
- (19) **L. curtipes** Thaxter, on *Bembidium bimaculatum* Kirby, N. America.
- (20) **L. decipiens** Thaxter, on *Galerita nigra* Chev., *G. æquinoctialis* Chaud., N. America.
- (21) **L. Diopsis** Thaxter, on *Diopsis thoracica* Westw., Africa.
- (22) **L. elegans** Thaxter, on *Harpalus pennsylvanicus* De G., N. America.
- (23) **L. elongata** Thaxter, on *Platynus cincticollis* Say, *P. extensicollis* Say, *P. melanarius* Dej., *P. ruficornis* Lec., *P. picticornis* Newm., *P. bicolor* Lec., *P. pusillus* Lec., *P. dissectus* Lec., *P. brunneomarginatus* Mann., *P. floridanus* Lec., *P. sinuatus* Dej., *P. ovipennis* Mann., *Anisodactylus baltimorensis* Say, *Colpodes purpuripennis* Chaud., *C. cæruleomarginatus* Chaud., *C. duplex* Bates, *C. grata* Bates, *C. petilis* Bates, *C. incultus* Bates, *C. sphodroides* Chaud., *C. cyanonotus* Chaud., *C. tenuicornis* Chaud., N. America. *Platynus ruficornis* Gøze, *Læmosthenes (Pristonychus) cavicola* Sch. Europe, *Platynus* sp., Asia (Japan), *Colpodes* sp., S. America, *Macrochilus biguttatus* Gøze, Africa.
- (24) **L. europæa** Thaxter, on *Chlænium æneocephalus* Dej., *C. chrysocephalus* Rossi, *Callistus lunatus* Fabr., *Aptinus mutilatus* Fabr., *Brachinus explodens* Duft., Europe.
- (25) **L. fasciculata** Peyritsch, on *Chlænium vestitus* F., *Omophron limbatum*, F., Europe.
- (26) **L. filifera** Thaxter, on *Anisodactylus Harrisii* Lec., *A. nigerrimus* Dej., *A. interpunctatus* Kirby, *Anisodactylus* spp. indet., *Harpalus erythropus* Dej., *H. pleuriticus* Kirby, N. America.
- (27) **L. flagellata** Peyritsch, on *Bembidium lunatum* Duft., Europe.
- (28) **L. fumosa** Thaxter, on *Platynus cincticollis* Say, N. America.
- (29) **L. Galeritæ** Thaxter, on *Galerita Janus* Fabr., *G. mexicana* Dej., *G. atripes* Lec., *Galerita* sp. indet., N. America.
- (30) **L. gibberosa** Thaxter, on *Platynus extensicollis* Say, N. America.
- (31) **L. Guerinii** Mont. et Robin, on *Gyretes sericeus* Lab., S. America; *G. compressus* Lec., N. America.

- (32) **L. Gyrinidarum** Thaxter, on *Gyrinus fraternus* Coup., *G. affinis* Aub., *G. ventralis* Kirby, *G. analis* Say, *G. confinis* Lec., *G. consobrinus* Lec., *G. plicifer* Lec., *Gyrinus* spp. indet., N. America; *G. urinator* Illig., Europe.
- (33) **L. Hageni** Thaxter, on *Termes mozambica* Hagen, Africa.
- (34) **L. Harpali** Thaxter, on *Harpalus pennsylvanicus* De G., N. America.
- (35) **L. inflata** Thaxter, on *Bradycellus rupestris* Say, N. America.
- (36) **L. Kunkelii** Giard, on *Mormolyce phyllodes* Hagenb., Asia (Java).
- (37) **L. lepida** Thaxter, on *Anisodactylus nigerrimus* Dej., N. America.
- (38) **L. longicollis** Thaxter, on *Galerita leptodera* Chaud., *Galerita* sp. indet., Africa.
- (39) **L. luxurians** Peyritsch, on *Bembidium* spp. indet., N. America, *Bembidium varium* Oliv., *B. bipunctatum* Duft., *B. flammulatum* Clairv., Europe.
- (40) **L. macrotheca** Thaxter, on *Anisodactylus ballimorensis* Say, *Anisodactylus* sp. indet., N. America.
- (41) **L. melanotheca** Thaxter, on *Galerita mexicana* Chaud., N. America.
- (42) **L. mexicana** Thaxter, on *Galerita mexicana* Chaud., *G. nigra* Chev., *G. æquinotialis* Chaud., N. America.
- (43) **L. minima** Thaxter, on *Callida pallidipennis* Chaud., N. America.
- (44) **L. Morionis** Thaxter, on *Morio Georgii* Pal., N. America.
- (45) **L. Nebriæ** Peyritsch, on *Nebria pallipes* Say, *N. Sahlbergi* Fisch, *N. gregaria* Fisch, N. America; *N. brunnea* Duft., *N. villæ* Dej., Europe.
- (46) **L. Oberthuri** Giard, on *Orectogyros heros* Reg., Madagascar.
- (47) **L. Orectogyri** Thaxter, on *Orectogyros Bedeli* Reg., Africa.
- (48) **L. Pachytelis** Thaxter, on *Pachyteles mexicanus* Chaud., N. America.
- (49) **L. palmella** Thaxter, on *Mormolyce phyllodes* Hagenb., Asia (Java).
- (50) **L. Panagæi** Thaxter, on *Panagæus crucigerus* Say, *P. fasciatus* Say, N. America.
- (51) **L. parvula** Thaxter, on *Platynus extensicollis* Say, *P. æruginosus* Dej., *Platynus* spp. indet., N. America.
- (52) **L. paupercula** Thaxter, on *Platynus melanarius* Dej., *P. ruficornis* Lec., *P. extensicollis* Say, N. America.
- (53) **L. pedicillata** Thaxter, on *Bembidium* spp. indet., N. America.
- (54) **L. perpendicularis** Thaxter, on *Bembidium* spp. indet., N. America.
- (55) **L. Pheropsophi** Thaxter, on *Pheropsophus æquinotialis* Linn., *Pheropsophus* spp. indet., S. America; *Pheropsophus marginatus* Dej. (?), *Pheropsophus* sp. indet., Africa.
- (56) **L. Philonthi** Thaxter, on *Philonthus debilis* Grav., *P. cunctans* Horn, *P. micans* Grav., *P. æqualis* Horn, *P. furvus* Nord, *Philonthus* spp. indet., N. America.
- (57) **L. polyphaga** Thaxter, on *Olisthopus parmatus* Say, *Stenolophus limbalis* Lec., *S. fuliginosus* Dej., *Badister maculatus* Lec., *Harpalus pleuriticus* Kirby, *Agonoderus pallipes* Fabr., *Loxandrus* several spp. (?), N. America; gen. indet., S. America (?); on *Amara* sp., Africa.
- (58) **L. proliferans** Thaxter, on *Eudema tropicum* Hope, *Eudema* sp. indet., *Chlænium tenuicollis* Fabr., *C. velutinus* Duft., Africa; *Dolichus* sp. (?), Asia (Japan).
- (59) **L. Pterostichi** Thaxter, on *Pterostichus adoxus* Say, *P. luctuosus* Dej., *P. mancus* Lec., *P. relictus* Newm., *Anisodactylus nigerrimus* Dej., N. America.

- (60) *L. Quedii* Thaxter, on *Quedius vernix* Lec., N. America.
- (61) *L. recta* Thaxter, on *Platynus extensicollis* Say, N. America.
- (62) *L. rigida* Thaxter, on *Pterostichus patruelis* Dej., N. America.
- (63) *L. Rougetii* Mont. et Robin, on *Brachinus crepitans* L., *B. explodens* Duft., *B. scolopeta* Fabr., Europe.
- (64) *L. scelophila* Thaxter, on *Platynus extensicollis* Say, N. America.
- (65) *L. Schizogenii* Thaxter, on *Schizogenius lineolatus* Say, *S. ferrugineus* Putz., *Clivina cordata* Putz., N. America.
- (66) *L. subterranea* Thaxter, on *Anophthalmus Menetriesii* Motsch, *A. pusio* Horn, N. America; *A. Motschulskyi* Schm., Europe.
- (67) *L. terminalis* Thaxter, on *Pterostichus luctuosus* Dej., N. America.
- (68) *L. texana* Thaxter, on *Brachinus* spp. indet., N. America.
- (69) *L. truncata* Thaxter, on *Bembidium* sp. indet., N. America.
- (70) *L. umbonata* Thaxter, on *Stenolophus ochropezus* Say, N. America.
- (71) *L. variabilis* Thaxter, on *Anomoglossus pusillus* Say, *Chlœnius æstivus* Say, *C. cumatilis* Lec., *C. cursor* Chev., *C. leucoscelis* Chaud., *C. floridanus* Horn, *C. pennsylvanicus* Say, *C. ruficaudis* Chaud., *C. sparsus* Lec., *C. texanus* Horn, *C. tricolor* Dej., *C. viridicollis* Reiche, *Omophron americanum* Dej., *Omophron* spp. indet., *Patrobus longicornis* Say, *Platynus extensicollis* Say, *Pterostichus adoxus* Say, *P. luctuosus* Dej., *P. corvinus* Dej., *P. caudicatus* Say, *P. Sayi* Brullé, *Nebria pallipes* Say, *Blethisa multipunctata* Fabr., *B. quadricollis* Bald., N. America; *Pterostichus* (?) sp., S. America.
- (72) *L. vulgaris* Peyritsch, on *Bembidium mexicanum* Dej., *B. lævigatum* Say, and many spp. indet., *Trechus chalybeus* Mann., N. America; *Bembidium littorale* Pz., *B. fasciolatum* Duft., *B. punctulatum* Drap., *B. lunatum* Duft., *B. obsoletum* Dej., *B. Andreæ* Sch., *B. flammulatum* Clairv., *B. decorum* Pz., *B. femoratum* Sturm., *B. bipunctatum* Duft., Europe; on gen. indet., Asia (?).
- (73) *L. zanzibarina* Thaxter, on *Crepidogaster bimaculata* Boh., Africa.

GENUS IX. TERATOMYCES. Receptacle of three superposed cells above which a series of smaller cells arranged in a transverse series give rise to numerous appendages which completely surround the bases of the (one or more) perithecia.

- (1) *T. mirificus* Thaxter, on *Acylophorus pronus* Er., N. America.
- (2) *T. Quedianus* Thaxter, on *Quedius ferox* Lec., N. America.
- (3) *T. brevicaulis* Thaxter, on *Actobius nanus* Horn, N. America.
- (4) *T. Actobii* Thaxter, on *Actobius nanus* Horn, N. America.

GENUS X. DIPLOMYCES. Receptacle symmetrical with paired posterior projections, the appendages and perithecia also paired.

- (1) *D. Actobianus* Thaxter, on *Actobius nanus* Horn, N. America.

GENUS XI. RHACHOMYCES. Receptacle consisting of a main axis of superposed cells from which on one side smaller appendiculate cells are separated, the perithecia sub-terminal.

- (1) *R. speluncalis* Thaxter, on *Anophthalmus pusio* Horn, N. America.
- (2) *R. lasiophorus* Thaxter, on *Atranus pubescens* Dej., *Badister micans* Lec., *Acupalpus carus* Lec., and gen. indet., N. America.

- (3) *R. arbusculus* Thaxter, on gen. indet., near *Lathrobium*, Africa.
- (4) *R. longissimus* Thaxter, on *Colpodes evanescens* Bates, N. America.
- (5) *R. furcatus* Thaxter, on *Othius fulvipennis* Fabr., Europe.
- (6) *R. hypogæus* Thaxter, on *Anophthalmus Bilimeki* Sturm., Europe.
- (7) *R. Lathrobii* Thaxter, on *Lathrobium longiusculum* Grav., *Lathrobium* sp. indet., N. America.
- (8) *R. pilosellus* (Robin), on *Lathrobium fulvipenne* Grav., Europe.

GENUS XII. CHÆTOMYCES. Receptacle a simple series of superposed cells, the appendages and perithecium forming a single vertical series.

- (1) *C. Pinophili* Thaxter, on *Pinophilus latipes* Er., N. America.

GENUS XIII. SPHALEROMYCES. Receptacle two-celled, the single simple appendage bearing a series of antheridial branchlets superposed in a single row.

- (1) *S. Lathrobii* Thaxter, on *Lathrobium nitidulum* Lec., *L. punctulatum* Lec., N. America.
- (2) *S. occidentalis* Thaxter, on *Pinophilus densus* Lec., N. America.

GENUS XIV. COMPSOMYCES. Receptacle two-celled, the upper cell bearing the appendages and stalked perithecium in a whorl. Perithecium with two stalk-cells, the lower appendiculate.

- (1) *C. verticillatus* Thaxter, on *Sunius longiusculus* Mann., N. America.

GENUS XV. MOSCHOMYCES. Receptacle two-celled, several arising from a compacted cellular base intruded into the body cavity of the host. Perithecium borne on two stalk-cells, the lower appendiculate.

- (1) *M. insignis* Thaxter, on *Sunius prolixus* Er., N. America.

GROUP II. Exogenæ. Antherozoids produced exogenously. Typically aquatic.

ORDER. Zodiomycetæ.

GENUS I. CERATOMYCES. Appendage tapering with lateral branches, receptacle few-celled, wall-cells of perithecium seven or more in each row.

- (1) *C. mirabilis* Thaxter, on *Tropisternus glaber* Hb., *T. nimbatus* Say, N. America.
- (2) *C. confusus* Thaxter, on *Tropisternus glaber* Hb., *T. nimbatus* Say, N. America.
- (3) *C. camptosporus* Thaxter, on *Tropisternus glaber* Hb., N. America.
- (4) *C. minisculus* Thaxter, on *Tropisternus nimbatus* Say, N. America.
- (5) *C. filiformis* Thaxter, on *Tropisternus glaber* Hb., *T. nimbatus* Say, N. America.
- (6) *C. rostratus* Thaxter, on *Hydrocombis fimbriatus* Melsh., *Philhydrus cinctus* Say, *P. nebulosus* Say, N. America.
- (7) *C. terrestris* Thaxter, on *Lathrobium punctulatum* Lec., N. America.
- (8) *C. furcatus* Thaxter, on *Berosus striatus* Say, N. America.
- (9) *C. contortus* Thaxter, on *Berosus striatus* Say, N. America.
- (10) *C. humilis* Thaxter, on *Berosus striatus* Say, N. America.

GENUS II. ZODIOMYCES. Receptacle parenchymatously multicellular, the numerous perithecia surrounded by sterile appendages arising from its cup-shaped extremity.

- (1) *Z. vorticellarius* Thaxter, on *Hydrocombis lacustris* Lec., *H. fimbriatus* Melsh., and sp. indet., N. America.

In addition to the forms above enumerated, which include one hundred and fifty-two species and twenty-eight genera, a certain number of undescribed forms are known, including several new genera. Of these, three species belong to the genus *Laboulbenia*, two of them North American, on *Bledius* and *Anophthalmus*, and one European, on *Patrobus* (Peyritsch); one to *Cantharomyces*, on *Ancyrophorus*; one to *Chitonomyces*, on an unknown host, together with a new genus, on *Bledius*, and a doubtful genus on *Tachinus*. The total number of forms known to exist, excluding certain doubtful species referred to by Peyritsch, is thus one hundred and fifty-eight.¹ Although this number may be assumed to illustrate the group in a general way, it is certain that many important additions are inevitable, and from the data available a rough estimate of the numbers of the family existent in all parts of the world would be from five hundred to one thousand.

The following descriptions, a majority of which first appeared in the "Proceedings" of the Academy, have been largely rewritten and revised with additional notes in the light of more abundant material and a more complete knowledge of the group. As will be observed, a limited number are here described for the first time, and include some of the most important additions to the family.

¹ To these must be added a new aquatic genus near *Chitonomyces*, which is alluded to under that genus, and two undescribed species of *Ceratomyces*.

FAMILY LABOULBENIACEÆ PEYRITSCH.

DIMORPHOMYCES Thaxter. Plate V, figs. 1-16.

Proc. Am. Acad. Arts and Sci., Vol. XXVIII, p. 157.

Diœcious. *Male individual* consisting of four superposed cells, the two distal ones sterile, the sub-basal producing a compound antheridium, the six antheridial cells of which are arranged in two antero-posterior rows and discharge into a common cavity lying above them, from which the antherozoids escape through a prominent tubular neck.

Female individual consisting of four superposed cells, the two distal ones sterile, the sub-basal cell giving rise to two or more perithecia and sterile appendages which alternate with one another on either side, forming a transverse series. Trichogynæ short, radiately branched. Spores once septate.

The material available for the illustration of this genus, although abundant, includes, unfortunately, no young individuals in which the first stages in the development of the primary perithecia are shown. Owing to the small size of the plant and the indistinctness of its septa, it has been difficult to determine with certainty the exact relation which the perithecia and sterile appendages bear to the receptacle. While in most cases the latter has seemed to consist of three superposed cells, as in fig. 1 or 5, in a few specimens I have thought that there was an indication of the presence of septa as is indicated in fig. 4. If the first of these alternatives proves to be correct, the portions of the receptacle which bear the appendages and perithecia must be considered as wing-like outgrowths from the basal cell; while in the second instance they would originate from a sub-basal cell. Although in no other genus, with the exception of *Amorphomyces*, is anything approaching a similar condition found, I am inclined to think that the first-mentioned alternative is the correct one.

In form and development the species of *Dimorphomyces* are very peculiar. There is a general triangular outline to the portion below the sterile cells of the receptacle, a tendency to a posterior convexity and anterior concavity; and in both species the first organs to be developed are a pair of primary perithecia symmetrically placed and followed immediately by a sterile appendage placed externally on either side. In many individuals there seems to be no further development (fig. 3); but very commonly two or four secondary perithecia are formed, alternating with as many sterile appendages. The process by which these organs are formed is unlike any corresponding process in other genera. Assuming that my observations are correct in deriving them from the sub-basal cell of the receptacle, the first step in their formation would consist in the production of two anterior projections from this cell symmetrically placed on either side of the median line. The tip of each projection is cut off, and the cell thus separated develops upward into a perithecium. Meanwhile a lateral proliferation takes place below this

septum, and from it arises a second projection, the upper portion of which is cut off as before, and develops into a primary appendage, external to each primary perithecium. This condition is represented in figs. 2 and 3. The same process may continue through the production of further successive lateral proliferations, new cells being separated as above described, and developing upward into new perithecia and sterile appendages. As a result of this process a fan-like habit is developed, a series of alternating perithecia and appendages extending obliquely upwards on either side from their common point of origin in the median line of the receptacle, their bases resting upon a unicellular margin (figs. 1 and 5), which results from its repeated proliferation. The alternation of perithecia with appendages appears to be invariable; except in abnormal cases, where, for example, a perithecium has failed to develop, as at the left in fig. 1.

The appendages themselves present no special peculiarities, and consist merely of a single series of superposed nearly cylindrical cells. The perithecium originates from a single cell that divides into a lower and upper portion, the former the primordial cell of the perithecium proper, the latter of the procarpe. The development of the former is made out with great difficulty, the septa being very indistinct. It is probable, however, that it corresponds in general with the course of development described as typical in the first part of this memoir; although in the mature perithecium all signs of septa have disappeared, and the cavity of the stalk-cell and of the perithecium are continuous (fig. 3), the single ascogenic cell with its ascus mass floating free within.

The spores are of the usual type, and are once-septate. As in the genus *Amorphomyces*, the members of any given spore pair produce one a male, the other a female individual; the two sexes being thus invariably associated, as in figs. 2 and 5.

The male individuals are very similar in the two known species, and are often indistinguishable. Owing to their minute size, I have been unable to obtain material of the youngest stages for figuring, the only early condition observed having been unfortunately lost in an attempt to mount it. In this specimen it was evident, as could be inferred from an examination of the mature individual, that the antheridium was developed as a lateral production from the sub-basal cell of the receptacle. The receptacle, as in the female, consists of four superposed cells, the two terminal ones sterile. The antheridium itself consists of a basal cell, above which are three small cells, of somewhat unequal size, from which the antheridial cells arise. The latter are arranged in three pairs; and all six cells discharge the antherozoids formed within them into a common cavity, that forms the slightly inflated base of the long tubular neck through which they are finally discharged. The formation and discharge of antherozoids continues for a considerable period, so that provision is made for the fertilization of as many secondary perithecia as may be formed upon the female individual; and the number of antherozoids eventually produced by a single individual must be very great.

The genus appears to bear no special relation to *Amorphomyces*, which, in all essential points of structure, with the exception of the remarkable similarity of its trichogyne, is widely different in both sexes. Yet it is singular that these, which are, with one exception, the only two diœcious genera so far discovered, should inhabit the same minute host.

Scientifically considered, the three diœcious genera, of which this may be taken as a type, may certainly claim a position first in importance among the Laboulbeniaceæ, if not among the Ascomycetes as a whole, since their morphology and development would seem to settle beyond

any reasonable doubt the vexed question as to the presence of sexuality in the higher fungi. The immediate relation of the present to other genera, with the exception of *Dimeromyces*, is not clear; yet it seems probable that among described forms the species of *Dichomyces* and *Peyritschiella* approach it more nearly than any others. In both of these instances the same tendency towards a bilateral development is combined with a close correspondence in the sexual organs.

DIMORPHOMYCES DENTICULATUS Thaxter. Plate V, figs. 11-16.

Proc. Am. Acad. Arts and Sci., Vol. XXVIII, p. 157.

Male individual. Receptacle of four superposed cells, the distal one tapering upward, and terminated by a more or less distinctly marked, usually slightly blackish, knob. Antheridium arising from the sub-basal cell and partly united to the sub-terminal cell of the receptacle; externally nearly straight, bulging internally; its main body about as long as the usually straight terminal neck, the base of which is distinctly inflated to form the cavity into which are discharged the antherozoids. Total length to tip of receptacle, 40μ ; to tip of antheridium, $50-55\mu$. Greatest width, 14μ .

Female individual. Sterile portion of the receptacle consisting of a large sub-terminal and much smaller nearly spherical terminal cell, the main portion consisting of two superposed cells forming a more or less three-sided body, the perithecia and sterile appendages arising in the manner characteristic of the genus. Perithecia slightly inflated, rather abruptly contracted to form the stalk portion; the tip oblique; one of the lip-cells projecting as a short but distinct tooth-like prominence; while just below this prominence a conspicuous tooth-like outgrowth arises from one of the anterior sub-terminal wall-cells, and extends obliquely upward and outward more than half its length beyond the tip of the perithecium. The stalk of the perithecium is usually strongly curved, so that the latter is bent backward beyond the terminal portion of the receptacle. Sterile appendages simple, septate, tapering slightly, usually bent away from the perithecia. Spores $22-25 \times 3\mu$. Perithecia $65-70 \times 15\mu$. Appendages about 110μ . Receptacle about 40μ long.

On *Falagria dissecta* Er., Waverly, Mass., and Kittery Point, Maine.

Better and more abundant material of this species has made necessary important changes in the original diagnosis above cited. The species is a rare one, occurring on the abdomen of its host close to the edges of the last abdominal rings on the upper or under sides, and may be seen projecting beyond their margin in a position indicated in fig. 2. They occur always in pairs, comprising the two sexes; and numerous pairs are not infrequently found crowded together and producing a little tuft which may be seen without great difficulty under a hand lens. The anterior face is usually turned towards the substratum, and the divergence of the appendages and perithecia gives the plant a characteristic habit, indicated in fig. 11, and makes it almost impossible to obtain a view which is either wholly posterior or wholly anterior. The species seems a very constant one, varying but slightly in size, and usually producing only two perithecia. The host, *Falagria*, may be obtained in great abundance from almost any decaying vegetable matter in fields, and is most readily captured by shaking such material over a white cloth. It is the smallest host known to be infested by any of the Laboulbeniaceæ.

DIMORPHOMYCES MUTICUS Thaxter. Plate V, figs. 1-10.

Proc. Am. Acad. Arts and Sci. Vol. XXIX, p. 104.

Male individual, as in *D. denticulatus*, slightly larger, the basal and sub-basal cells often more or less suffused posteriorly with blackish brown.

Female individual, as in *D. denticulatus*, more rigid and flattened in habit, the perithecia and appendages not bent away from one another. The perithecium larger, longer, proportionately more slender, its apex truncate or but slightly oblique, the sub-terminal wall-cells producing no tooth-like outgrowth. Spores $23-26 \times 3\mu$. Perithecia $75-90 \times 15\mu$. Total length to tip of perithecium, $90-130\mu$.

On *Falagria dissecta* Er., Waverly, Mass., and Kittery Point, Maine.

This species occurs sometimes in company with the last on the same host. It is at once distinguished by its larger unarmed perithecia, which never show any indication of the prominence so characteristic of *D. denticulatus*. Its general habit, though it develops under identical conditions, is also quite different from that of the preceding species, and no tendency to an antero-posterior divergence is observable between the perithecia and appendages. The conformation of the tips of the perithecia in either case, as shown in figs. 7 and 13, is also very different. Four or even more perithecia are not rarely developed in this species, and in fig. 1 an instance is shown of an unusually highly developed individual in which the single primary perithecium that remains is bent to the left, its fellow having been broken off or destroyed, while five new secondary perithecia are developing on either side; the youngest, at the extreme right, consisting of a mere prominence not yet separated from the proliferating marginal cell described in the preceding account of the genus. The same figure shows the remarkable phenomenon of an almost complete development of two male spores within the old primary perithecium. The species is more abundant than the preceding and more readily seen, from the greater size of its projecting perithecia.

DIMEROMYCES nov. gen. Plate IV, figs. 12-17.

Diœcious. Male individual consisting of a series of superposed cells from which are produced, laterally, sterile appendages and antheridia in a single series. The antheridium compound, consisting of a stalk-cell followed by four basal cells, above which are six antheridial cells arranged symmetrically in the same plane, and discharging the antherozoids into a common cavity, whence they make their escape through a terminal orifice, at the tip of a long, slender, tubular, terminal prolongation.

Female individual like the male, the antheridia being replaced by perithecia. The latter stalked, the cavity of the stalk-cell, basal cells and perithecium proper, eventually continuous, through the absorption of all the septa.

This is in some respects among the most interesting of all the genera of Laboulbeniaceæ, since it combines with a diœcious habit a more complicated development of the male individual than is found in any other instance. In *Dimorphomyces*, to which it is more closely allied than to any other genus, the antheridium is nearly, if not quite, as highly developed; but it is always

solitary, and the receptacle is very greatly reduced, being quite different from that of the female; while in the present genus it differs only in its slightly smaller size. The antheridium is almost identical in structure with that of *Dimorphomyces*, from which it differs only in its more slender and elongate form, and in its free stalk-cell. The perithecium also, when mature, shows the same remarkable absorption of its basal septa which one finds in the last-mentioned genus, its whole cavity, from the apex to the insertion of the stalk-cell, becoming continuous about the time that the spores begin to mature. The trichogynæ, as far as can be determined from a somewhat imperfect specimen (fig. 17), is small and irregularly inflated.

The receptacle is quite unique in structure, and apparently in development. The material available does not, unfortunately, illustrate the complete development, there being no very young stages; but it is evident that the young plant ends with a single primary appendage, which is the upper one of the series in the mature individual. Then, by successive divisions of the basal cell of the receptacle, new cells appear to be cut off from its distal end; each of which, in its turn, cuts off a small cell, always on the same side, from which the secondary appendages, the perithecia, and the antheridia are directly developed. A somewhat similar arrangement of organs is found in the female individual of *Dimorphomyces*; but in this case the series are twofold and the proliferations terminal from wing-like lateral outgrowths.

DIMEROMYCES AFRICANUS nov. sp. Plate IV, figs. 12-18.

Male individual brownish. Receptacle consisting of usually seven very obliquely superposed cells, from all of which, except the basal, may be developed on the side which is uppermost, a sterile appendage or an antheridium in no regular order except that the terminal cell always bears an appendage. Antheridia rarely more than three, usually two, somewhat flattened, borne on a short free stalk-cell, the basal cells small, the six antheridial cells in two transverse rows of three each, the neck long and slender, slightly curved, its base distinctly inflated. The appendages simple, rigid, septate, tapering, becoming blackish brown; the sub-basal cell somewhat constricted and deeply suffused with blackish brown. Antherozoids about $2.5 \times .75\mu$, rod-like. Antheridia, including stalk-cell, $60 \times 10\mu$, the neck, including its inflated base, about 38μ . Receptacle, $125-150 \times 35\mu$.

Female individual like the male, but larger; the receptacle usually consisting of eleven cells, the antheridia replaced by banana-shaped perithecia, one to four in number, short-stalked, brownish; the distal end more deeply suffused, and tapering somewhat abruptly to the broadly truncate apex. Spores once septate $75 \times 5.5\mu$. Perithecia, $140-175 \times 26-35\mu$, including stalk-cell. Appendages (longer), $175-260\mu$. Receptacle, $120-150 \times 35-50\mu$.

On *Pachyteles luteus* Hope, Mt. Coffee, Liberia (O. F. Cooke).

The types of this interesting form were found on two specimens of the host which were among the insects kindly loaned me for examination by Professor Cooke, and occurred on the inferior surface of the abdomen near the base of the two posterior pairs of legs. I was not able to determine from the material whether the sexes always grow in pairs, since from their position of growth it was not possible to remove a portion of the chitin bearing them without injuring the insect. It is altogether probable, however, that the development of the spore pairs corresponds to that of the other diœcious forms (*Amorphomyces* and *Dimorphomyces*).

HAPLOMYCES. Plate VII, figs. 1-10.

Proc. Am. Acad. Arts and Sci. Vol. XXVIII, p. 159.

Receptacle consisting of two small superposed cells from which arise the single perithecium and the single antheridial appendage. Perithecium large, pointed, borne on a single stalk-cell surmounted by three basal cells. Antheridial appendage consisting of a basal cell surmounted by a terminal body, the antheridium, entirely divided by anastomosing septa into numerous small cells, and furnished with a short lateral projection, together with a sub-terminal short spine-like process arising from a rounded base. Asci four-spored, arising from eight ascogenic cells. Spores once septate.

Owing to the fact that no fresh material of this genus, or any of its younger stages have been examined, there are numerous points connected with it which need to be made clear. Unlike the succeeding genus, *Cantharomyces*, its nearest ally, the antheridium appears to be terminal, not lateral. No discharge of antherozoids was observed in any of the specimens examined, and it is uncertain how and where such discharge takes place. Certainly not through the terminal spine-like process, so characteristic in the genus, which is undoubtedly a peculiarly modified sterile cell, perhaps the remains of the original terminal spore segment. It seems more probable that a lateral projection prominent in some specimens (at the right in fig. 3) represents the point of discharge; but what relation the irregularly honeycomb-like mass of cells composing the body of the antheridium bears to this projection, or how many of these cells are really spermatie, it is impossible to say. Examined with an immersion, indications of a central cavity, containing small roundish bodies, probably antherozoids, and extending upward and outward to the external projection previously mentioned, may be made out, though not with sufficient definiteness to enable one to figure these structures. From analogy with related genera, however, there can be little doubt that some such arrangement of the spermatie cells about a common cavity must exist.

The perithecium is remarkable from the fact that it contains eight ascogenic cells arranged symmetrically in four pairs, a condition only occurring in this and, perhaps, in the succeeding genus.

The hosts of these curious little forms all belong to the staphylinid genus *Bledius*, common further south along the sandy or gravelly margins of streams, especially in shady places, where they may be found under stones or burrowing in the sand. The only material examined has been that contained in the collection of the Museum of Comparative Zoology at Cambridge.

HAPLOMYCES CALIFORNICUS Thaxter. Plate V, figs. 1-4.

Proc. Am. Acad. Arts and Sci. Vol. XXVIII, p. 159.

Perithecia olive brown, tapering abruptly to the small blunt apex, greatly inflated externally, internally nearly straight; a distinct prominence, the base of the old trichogyne, usually visible on its anterior face below the apex, its basal cells short, wider than long, more or less suffused with olive brown, the stalk-cell stout, sub-triangular, hyaline. Receptacle small; its basal cell nearly hyaline, more than twice as large as the sub-basal, which is intensely blackened

and quite opaque, as is the basal cell of the appendage, except along its inner margin. Antheridium twice as long as broad, slightly convex inwardly and concave outwardly; its thorn-like appendage sharp, prominent. Spores, $37-40 \times 3 \mu$. Perithecia, $130-145 \times 65 \mu$, the stalk-cell $45-50 \times 38 \mu$. Receptacle, $45-55 \times 15-18 \mu$. Antheridium, $33 \times 19 \mu$. Total length of appendage, $48-55 \mu$. Total length to tip of perithecium, $240-260 \mu$.

On *Bledius ornatus* Lec., California.

This species was found growing on the abdomen of a single specimen of its host, examined in the collection of the Museum of Comparative Zoology. It seems to be sufficiently distinguished from the succeeding species by its olive brown color and very differently shaped perithecium. The fourteen type specimens show no variation from the form represented in the plate.

HAPLOMYCES VIRGINIANUS Thaxter. Plate V, figs. 7-10.

Proc. Am. Acad. Arts and Sci. Vol. XXVIII, p. 160.

Perithecium short, stout, straw-yellow, outwardly inflated, the inner margin nearly straight, the distal portion conical, its apex bluntly pointed; stalk-cell long, nearly cylindrical, distally expanded slightly, the basal cells of perithecium very small, almost obsolete. Basal cell of receptacle large, the distal cell very small, and several times as broad as long, the stalk-cell of the perithecium arising from it, but also connected with the distal portion of the basal cell. Basal cell of antheridial appendage squarish, slightly broader than long, the antheridium rounded, its reticulations coarse, the thorn-like apiculus very fine (about 5μ long) and abruptly distinguished from its flattened base. Spores, $33 \times 3.7 \mu$. Perithecia, $110-130 \times 55-60 \mu$. Stalk-cell of perithecium, $75-110 \times 19-25 \mu$. Antheridium, 18μ long, $22-23 \mu$ wide. Receptacle, basal cell, $45-50 \times 18-19 \mu$, distal cell about $18.5 \times 6 \mu$. Total length to tip of perithecium, $220-275 \mu$. Total length of appendage, $30-33 \mu$.

On *Bledius emarginatus* Say, Virginia.

This curious little species was found growing on the abdomen of its host. It is very distinct from either of the remaining forms, and although approaching *H. californicus* more closely in the shape of its perithecium, is at once distinguished by the great elongation of the latter's stalk-cell, which is associated with a remarkable reduction in the size of its basal cells. The sub-basal cell of the receptacle is so reduced that the stalk-cell of the perithecium appears at first to arise from the basal cell. The antheridial appendage, though almost identical in the other two species, is here distinctly different in form and general appearance.

HAPLOMYCES TEXANUS Thaxter. Plate V, figs. 5-6a.

Proc. Am. Acad. Arts and Sci. Vol. XXVIII, p. 160.

Perithecia almost symmetrically conical, straw-yellow, tapering to the rather blunt apex; the stalk-cell nearly hyaline, more than twice as long as broad, more slender at the base; the basal cells elongate, nearly equal. Receptacle small, the basal cell nearly hyaline; the distal cell very small, slightly broader than long, sometimes blackened and opaque, the opacity including the lower outer portion of the basal cell of the appendage, the unblackened portion of which,

together with the antheridium, becomes suffused with brown. Spores, $40-45 \times 3.7 \mu$. Perithecia, $165-185 \times 50-55 \mu$. Stalk-cell of perithecium, $65-90 \times 26-33 \mu$. Antheridium, $32 \times 18 \mu$. Receptacle, $37-45 \times 18 \mu$. Total length to tip of perithecium, $315-370 \mu$. Total length of antheridial appendage $35-40 \mu$.

On *Bledius rubiginosus* Er., Texas.

Distinguished from the preceding species by its pale yellowish color, conical, nearly straight perithecium, and by the elongated basal cells of the latter.

The two varieties of this form represented in figs. 5 and 6 occurred together on the abdomen of the same individual; and though the blackened form may be taken as the type, it is improbable that the two are distinct, since similar variations in color are common in other cases.

CANTHAROMYCES Thaxter. Plate V, figs. 11-24.

Proc. Am. Acad. Arts and Sci. Vol. XXIV, p. 9; l.c. Vol. XXVIII, p. 161.

Receptacle consisting of two superposed cells, the distal producing one or more stalked perithecia, and one or more antheridial appendages. Perithecia sub-conical, borne on a single stalk-cell surmounted by three basal cells. Antheridial appendages consisting of two superposed cells, terminated by one or two cells which may bear several branches, the sub-basal cell divided into two parts longitudinally or obliquely, one of which (the antheridium) is subdivided by anastomosing septa into numerous small cells. Spores once septate. Trichogyne filamentous.

This genus is very closely allied to the preceding, differing only in the fact that the antheridium is not terminal, but lateral, on an appendage terminated by sterile branches and destitute of the spine-like process characteristic of *Haplomyces*. The general relations of its parts are otherwise similar, and its antheridium possesses the same characteristic irregularly honey-combed structure. In *C. Bledii*, the only species abundant material of which has been examined, two or even three perithecia may arise from the same receptacle, and very rarely two appendages. In the absence of fresh material, except in the case of the very minute *C. pusillus*, the exact nature and relations of the spermatocytic cells remains a matter of doubt. In one specimen of *C. Bledii*, a well-developed trichogyne is present, rather copiously branched and bearing no resemblance to the greatly reduced type characteristic of *Peyritschiella* and its allies. As in *Haplomyces*, there appear to be eight ascogonic cells, but this point has not been definitely determined. The species all occur on beetles belonging to the Staphylinidæ.

CANTHAROMYCES BLEDDII Thaxter. Plate VII, figs. 17-24.

Proc. Am. Acad. Arts and Sci. Vol. XXIV, p. 10.

Color pale yellowish. Perithecia sub-conical, nearly symmetrical, basally inflated, borne on a well-developed stalk-cell surmounted by three smaller basal cells, one to three arising from the sub-basal cell of the receptacle. Receptacle consisting of a basal and somewhat larger sub-basal cell; often deeply and broadly blackened externally and inferiorly, in which case it projects laterally. Appendage usually single, rarely two arising from the same receptacle;

consisting of a squarish basal cell followed by a somewhat larger sub-basal cell, almost the whole of which becomes divided into numerous small cells to form the antheridium proper, which is bordered internally by a narrow sterile cell above which the appendage becomes repeatedly and variously branched; the branches seldom extending beyond the middle of the perithecium. Spores, $25 \times 3.5 \mu$. Perithecia, $90-130 \times 33-55 \mu$, average, $114 \times 42 \mu$. Total length of appendage, $90-180 \mu$, average, 150μ . Total length to tip of perithecia, $200-370 \mu$, average, 280μ .

On *Bledius assimilis*, Champaign, Ill.

I am indebted to the courtesy of Prof. S. A. Forbes for abundant material of this species, kindly sent me from the locality mentioned. A single undetermined species of *Bledius*, from northern Illinois in the Museum of Comparative Zoology, was also found infested by the same parasite; but no fresh material has been available for examination. The species varies very considerably in size; and forms in which the sub-basal cell is blackened might be mistaken for a distinct species, owing to the slight distortion which accompanies the discoloration. It occurs on all parts of the host, even the legs and antennæ. A species bearing some resemblance to the present form was also found on a species of *Ancyrophorus* from Lake Superior; but the two specimens examined are not sufficiently perfect to warrant their description.

CANTHAROMYCES OCCIDENTALIS Thaxter. Plate VII, figs. 15-16.

Proc. Am. Acad. Arts and Sci. Vol. XXVIII, p. 161.

More or less suffused with brown. Perithecium rather short, sub-conical, slightly inflated toward the base; the distal portion very slightly curved outward, the apex bluntly pointed; stalk-cell large, cylindrical, not exceeding the antheridium; basal cells each several times as long as broad. Basal cell of receptacle very small, the sub-basal cell much larger, inflated without blackening, or externally and inferiorly deeply blackened and slightly incurved. Basal cell of the appendage similar to the distal cell of the receptacle, larger and unmodified, or similarly blackened; the sub-basal cell large, its upper inner portion obliquely cut off and divided into numerous small cells to form the antheridium, which bulges slightly on the inner side; the appendage terminated by several superposed cells. Perithecium, $96-100 \times 60 \mu$. Stalk-cell of perithecium, $120-140 \times 26 \mu$. Length of appendage to tip of antheridium, $110-150 \mu$. Total length to tip of perithecium, $280-335 \mu$.

On *Bledius armatus* Er., Utah.

Distinguished from *C. Bledii* by its brown color, the greater elongation of the basal cells of the perithecium, and the relatively small antheridium, which in *C. Bledii* is external and comprises five-sixths to three-quarters of the sub-basal cell. The two specimens examined have each a single perithecium, and but one appendage, the tip of which is somewhat broken. A number of young specimens apparently belonging to this species, and occurring on *B. jacobinus* Lec., have the terminal portion of the appendage unbranched and consisting of a short tapering series of superposed cells.

The figures given represent the two type specimens which were found on the abdomen of the host.

CANTHAROMYCES PUSILLUS Thaxter. Plate VII, figs. 11-14.

Proc. Am. Acad. Arts and Sci. Vol. XXIX, p. 100.

Perithecium becoming reddish brown, inflated just above the base, the distal portion conical, tapering to a blunt symmetrical apex, borne on a rather short narrow stalk-cell bent towards the appendage and separated from the perithecium by three small sub-triangular basal cells. Receptacle consisting of a very small basal and a much larger rounded sub-basal cell, more or less suffused with brown, which gives rise to the stalk-cell of the perithecium and the appendage. Antheridial appendage consisting of a large squarish basal cell followed by the antheridium proper, which is primarily a large squarish cell, its outer half, or more, becoming divided by anastomosing septa into numerous small cells, the inner portion also showing a division into two or three larger cells; the whole bearing terminally a series of usually three superposed flattened cells, strongly constricted at the septa, and giving rise distally to from one to three simple cylindrical, nearly hyaline, sparingly septate branches, usually exceeding the perithecium in length. Spores, $18 \times 2 \mu$. Perithecia, $22-26 \times 30-55 \mu$. Total length to tip of perithecia, $80-85 \mu$, to tip of appendages, $90-120 \mu$.

On *Trogophlæus* sp. York, Maine; Waverly, Mass.

This species is perhaps the smallest of the known forms of Laboulbeniaceæ, and is somewhat difficult to discover and remove from the legs or elytra of its host, where, however, it is not rarely found. Owing to its minute size, the detailed structure of the antheridium was not plainly made out, neither was any discharge of antherozoids noticed. Its structure corresponds so closely, however, to that characteristic of the genus as emended, that there can be little doubt of the correctness of its generic reference. It occurs more commonly on the legs or near the tips of the elytra of its host, a small blackish staphylinid common on wet logs along the margins of brooks or in wet rubbish caught in similar situations.

EUCANTHAROMYCES, Thaxter. Plate V, figs. 25-27.

Receptacle consisting of two superposed cells, giving rise on one side to a free stalked perithecium, on the other to a free appendage. The appendage consisting of a basal and sub-basal cell terminated by a compound antheridium. The antheridium formed from numerous small cells, obliquely superposed in three rows, bordered externally by a sterile cell, and terminated by a cavity from which the antherozoids are discharged through a short, irregular, finger-like projection.

This genus is based upon the peculiar structure of its antheridium, which appears to be distinctly different from the honey-comb-like body which occurs in Haplomyces and Cantharomyces, as well as from the more simple form illustrated by Camptomyces, which is, probably, its nearest ally. The material examined consists of but two type specimens, in one of which the antheridium was in perfect condition, the terminal cavity being filled with antherozoids. It is impossible to determine in this specimen whether all or only a few of the small cells which compose the antheridium are antheridial cells; but, from analogy with Dimorphomyces and Peyritschiella, it seems probable that the majority of them are; and that the cells represented in

the figure (Plate VII, fig. 27) merely represent the bases of such antheridial cells; the terminal portions extending upward and inward, and discharging into the common cavity. This matter cannot, however, be determined without an examination of fresh material of immature specimens.

EUCANTHAROMYCES ATRANI Thaxter. Plate V, figs. 25-27.

Proc. Am. Acad. Arts and Sci. Vol. XXX, p. 480.

Pale straw-colored. Perithecium rather long, slightly inflated, tapering to a blunt apex with rounded lips, its stalk consisting of a single large free basal cell surmounted by three smaller cells. Basal and sub-basal cells of the receptacle long and very obliquely superposed, lying almost side by side. The appendage consisting of a basal cell not wholly free, but partially connected with the stalk-cell of the perithecium at its base, followed by a second sub-triangular cell, the oblique upper walls of which separate it on the inside from the body of the antheridium proper, and on the outside from the narrow cell which forms the sterile margin of the latter. Antheridium sub-cylindrical with rounded apex, consisting of three series of obliquely superposed cells, decreasing in size from below upward, and running obliquely upward and outward, the lower series of six cells, the middle of four, and the upper of two; the three series terminating in a common cavity filled with antherozoids, which are discharged through a terminal irregular, finger-like projection, which is bent strongly outward. Perithecium, $135 \times 35 \mu$. Length to tip of perithecium, 260μ . To tip of antheridium, 150μ .

On *Atranus pubescens* Dej., Virginia.

Two specimens of this form were found in company with *Rhachomyces lasiophorus*, on an example of *Atranus* kindly sent me by Mr. Pergande, and, although carefully sought for on all the available material of its rather rare host, has not been again observed. Neither of the specimens, which are both figured in the plate, are fully mature, and there is doubtless some slight further development of the perithecium. It is unlikely, however, that any difficulty will be encountered in its subsequent identification.

CAMPTOMYCES Thaxter. Plate VI, figs. 1-6.

Proc. Am. Acad. Arts and Sci. Vol. XXIX, p. 109.

Receptacle consisting of two superposed cells, the upper bearing the short-stalked perithecium laterally and the antheridial appendage terminally. Perithecium narrow, with coarse-lipped asymmetrical apex. Appendage consisting of a single large basal cell bearing the antheridium terminally. Antheridium multicellular, sub-conical, with a prominent terminal pore for the discharge of the numerous roundish antherozoids. Trichogyne developed as a small vesicular prominence from a permanent ear-like appendage which arises laterally from the young perithecium. Ascogenic cells two in number. Spores once septate.

It is much to be regretted that in this genus, as in all the genera closely allied to it in which the antheridium appears to be a terminal organ, no material is available which illustrates the first steps in its production. In the youngest conditions examined, the antheridium has, in all instances, attained nearly complete development, even when the perithecium is a mere bud from

the sub-basal cell of the receptacle. Whether the antheridium as a whole is truly terminal, and developed from the smaller of the two primary spore segments, is uncertain. When mature, it is a somewhat complicated organ; but in a general way corresponds to that of *Dimorphomyces*, except in the number and arrangement of its antheridial cells. The latter appear to be placed in probably two, possibly three, vertical rows, each cell extending obliquely inward and upward towards a general lateral and partly central cavity into which they discharge, and which is usually well filled with irregularly squarish or roundish antherozoids. I have been unable to make out to my own satisfaction whether all the smaller cells of the antheridium are spermatic, and what their exact disposition is. The figures given (5 and 6) represent only in a general way the relations of the cells to the cavity for the reception of antherozoids; the view in the one case being sectional in a plane which does not show the openings through which the antheridial cells discharge their contents; in the other (fig. 6), showing the appearances visible on the anterior (inner) surface of the organ. The antherozoids are produced in very large numbers, and no form that I have seen is so well adapted to illustrate their discharge, which almost invariably occurs when the specimen is placed in water. This is perhaps connected with the fact that the trichogyne is very rudimentary, consisting of a small vesicular prominence, with one or two short projections, and is not in close proximity to the antheridium, so that the production of a large number of male bodies is necessary to insure fertilization. The carpogenic cell is very large, and the trichophoric cell bears the trichogyne laterally and anteriorly, the latter subtended by a peculiar and well-marked prominence. This prominence, at the left in fig. 4, constitutes the basal portion of the trichogyne, the receptive portion of which is seen in the angle between it and the projecting apex of the trichophoric cell. The latter is separated from the base of the trichogyne by a septum which was accidentally omitted from the figure. The cavity of this basal portion, which becomes indurated and persists as a slight projection on the mature perithecium (fig. 2), is *not*, as represented, continuous with that of the trichophoric cell. The ascogenic cells are two in number, and the asci do not seem strictly biserial.

CAMPTOMYCES MELANOPUS Thaxter. Plate VI, figs. 1-6.

Proc. Am. Acad. Arts and Sci. Vol. XXIX, p. 101.

Perithecium tinged with brownish, slightly inflated towards the base, its distal half narrow, tapering gradually to the rounded attenuated apex, below which on one side is a rounded projection; borne on a large sub-triangular stalk-cell, surmounted by three smaller basal cells. Receptacle narrowly funnel-shaped, tapering to a pointed base, and consisting of a large basal cell, slightly translucent near its lower extremity, but otherwise becoming wholly opaque, followed by a flattened sub-basal cell, from which the mature perithecium with its stalk project nearly at right angles to the long axis of the receptacle, while distally it bears the appendage. Appendage consisting of a single squarish cell, followed by a flattened cell which bears terminally the sub-conical, slightly asymmetrical antheridium. Spores about $30 \times 3.5 \mu$. Perithecium, $130-150 \times 30-33 \mu$. Total length to tip of antheridium, $110-125 \mu$. Greatest width, 25μ . Antheridium, $25 \times 16 \mu$.

On *Sunius prolixus* Er., Waverly, Mass., and York, Maine. On *S. longiusculus* Mann., Kittery Point, Maine.

This curious species occurs rather rarely, more often on the upper than on the inferior surface of the abdomen of the two hosts mentioned, the receptacle lying close against the surface, while the perithecia project outward, often backward. Specimens on *S. longiusculus* are somewhat smaller and much paler than those on the larger host, the basal cell of the receptacle being more or less translucent. The form is not easily overlooked when mature, occurring usually in groups of half-a-dozen or more. The hosts may be found in dry hay or other rubbish in cultivated land.

ENARTHROMYCES nov. gen. Plates III-IV.

Receptacle consisting of a simple series of superposed cells, the distal ones bearing sterile appendages, those below giving rise to antheridia or perithecia or remaining sterile. Antheridia compound, terminally pointed and perforate, the six antheridial cells converging upward to a general cavity, into which they empty through narrow necks. Trichogyne simple, two-celled. Perithecia stalked, one or more formed by direct budding from the cells of the receptacle.

In the form and structure of its antheridium, and to some extent of its perithecium, this remarkable genus recalls *Peyritschiella*, to which it is undoubtedly more closely related than to any other. The series of specimens which constitute the types of the single species contain no very young individuals; yet it is apparent that, after the axis is formed and most of the sterile appendages have been produced, an antheridium arises, first originating as a lateral bud, in such a position that the first trichogyne when mature lies beside its apex. The antheridium is the largest thus far observed, of the compound type, and its general structure may be made out with no great difficulty. The antheridial cells are irregularly flask-shaped, and occupy the somewhat inflated basal portion of the organ, the distal part being more or less conical, and apparently originating from a single cell, the remains of a septum being usually visible (Plate III, fig. 19) just above the openings of the canals through which the contents of the antheridial cells are discharged. The cavity which it contains is of considerable size, and is often filled with free antherozoids. The latter are larger than other known forms of endogenous origin, and seem to be surrounded by a thin wall at the time of their final discharge. The trichogyne is quite peculiar, and invariable in form, being rather short and inflated, septate near the middle, and prolonged into a short terminal projection (Plate III, fig. 17, *tr*), which seems to be the only portion that is receptive, the remainder being distinctly thick walled. Indeed, it is only the terminal part of this projection that is very thin walled; so that, after fertilization, when this receptive portion has withered, the trichogyne appears to end in a short, cylindrical, and distally truncate and perforate outgrowth (fig. 18, *tr*). The young perithecia arise as lateral buds from the cells of the axis, becoming cut off from it in the form of free clavate cells (fig. 13), which become once septate (fig. 14) and follow the course of development described in Part I (p. 228).

ENARTHROMYCES INDICUS nov. sp. Plate III, figs. 13-19; Plate IV, figs. 8-11.

Pale amber or straw colored. Perithecia large, sub-cylindrical, terminally rather abruptly and symmetrically rounded below the short, clearly distinguished, broadly truncate apex, the lip-

cells of which end in papillate enlargements, while one of them produces posteriorly a clavate outgrowth bent abruptly upward near its base and extending free above the apex. Below the base of this projection, and on the same side, the perithecium is prominently hunched. Basal cells of the perithecium often rounded and bulging. Receptacle consisting of from fifteen to twenty superposed cells, somewhat longer than broad, the two lowest always sterile, the third always producing a perithecium, the sixth, more commonly the seventh, producing an antheridium; the cells immediately above the third producing perithecia or remaining sterile; those immediately above the sixth or seventh producing perithecia or antheridia or remaining sterile, the total number of antheridia rarely exceeding three; the perithecia rarely produced two from a single cell. The terminal cells of the receptacle, usually five or six in number, bearing septate, simple, lateral, sterile appendages. The latter straight, usually two borne on opposite sides of a given cell, but sometimes three or four from the same cell, deeply blackened and somewhat constricted in the region of their basal septum, consisting more commonly of seven cells, the fourth and sixth, and notably the fifth, broader and shorter than the others, the terminal cell longer than the rest and tapering to a blunt tip. Similar appendages rarely produced even below the uppermost perithecium. Spores, very long and slender, $120-130 \times 5 \mu$. Perithecia, $140-160 \times 50-60 \mu$; the outgrowth, $35 \times 10 \mu$; the stalk-cell, $50-85 \times 25-30 \mu$. Receptacle, $400-680 \times 25-35 \mu$; average, $500 \times 28 \mu$. Appendages, $140-200 \times 20 \mu$.

On *Pheropsophus* sp., Booloo Valley, banks of the Beas River, Northwest India.

Sufficiently abundant material of this fine species was obtained from the inferior surface of the thorax and abdomen of an undetermined *Pheropsophus* from the above-mentioned locality in the collection of the Museum of Comparative Zoology. Although varying somewhat in the number of perithecia developed, it seems to be an unusually constant form. Even the sterile appendages, although they vary in number in different individuals, are remarkably uniform, and rarely vary in respect to the number of cells which compose them. In many cases the first, and sometimes others of the perithecia become aborted, as a result of the non-fertilization of their trichogynes; and there may be three or even more such undeveloped perithecia on the same individual, with from one to three or even four which have reached maturity (Plate IV, fig. 8), so that although there are more commonly not more than two perithecia in a given individual, there may be six to eight, developed and undeveloped, in exceptional cases. In their color, habit, and peculiarly blackened bases, the sterile appendages, curiously enough, recall those of the *Laboulbenia* (*L. Pheropsophi*), which infests a similar host in Africa and South America; so much so that a young specimen, which was the first examined, was for the moment mistaken for an abnormal condition of this species. Owing to the large size of the sexual organs, this form offers unusually good opportunities for a closer study of the sexual processes, and it is to be regretted that it should occur in so remote a locality.

It seems doubtful whether the lower half of the two-celled body described as the trichogyne is not morphologically a portion of the trichophoric cell, since, though it is separated from the latter by a constriction, no septum is visible between them. In one instance, a second trichogyne was seen developed from the base of this basal half, the first trichogyne having failed to become fertilized.

PEYRITSCHIELLA Thaxter. Plate VI, figs. 7-24; Plate II, fig. 12.

Proc. Am. Acad. Arts and Sci. Vol. XXIV, p. 8, 1890.

Receptacle composed of four superposed areas: a basal consisting of a single cell; a sub-basal consisting of a single cell or of several cells transversely and asymmetrically disposed in a single row, one or more of which may be appendiculate; a sub-terminal area consisting of a similar series of several cells appendiculate at either side, and, on one side only, producing the single antheridium; and, lastly, a terminal series like the sub-terminal, but bearing one, rarely two, perithecia centrally placed; the cells of the series external to the perithecia, and the cell between them, if there are two, appendiculate. Antheridium conical, compound, forming a sharp, tooth-like projection on one side. Appendages simple, continuous, separated from the cell which bears them by a prominently constricted, usually blackened septum. Spores once septate. Perithecia symmetrical or nearly so, the tips ending in four papillæ.

This, together with the following and very nearly related genus *Dichomyces*, constitutes a peculiarly well marked type among the Laboulbeniaceæ, and no other form possessing a compound antheridium, with the exception of *Dimorphomyces*, presents the same tendency towards the production of a bilaterally symmetrical receptacle, which is so perfectly developed in *Dichomyces*. In the present genus, there is always an irregularity in the form, and an asymmetry in the disposition of the cells, especially in the two lower transverse series; and though in *P. geminata* a greater degree of symmetry is attained than in any other species, the lower series is always asymmetrical, and in all cases only a single antheridium is ever found.

The development of the receptacle is comparatively simple. The germinating spore, as in fig. 11, develops a terminal appendage which corresponds to the appendage lying at the left of the perithecium in figs. 8 and 10, or between the two perithecia in fig. 7. The larger, lower segment of the spore then divides into four cells, by the formation of three septa (fig. 12). The lower of these, the basal cell of the receptacle, undergoes no further modification, and in the single species *P. curvata*, the sub-basal cell remains unchanged. In all the other species, however, the sub-basal cell and the two cells above it become divided in a characteristic fashion. This division is effected by the formation of oblique septa cutting off the two upper angles of the cell, as in fig. 13. The small triangular cells thus formed begin to grow obliquely outward and upward, as seen at the right in fig. 13, and through the formation of further oblique divisions in these cells the characteristic transverse series result (fig. 14). The number and position of the appendages varies in different species and in different individuals, as indicated by the figures, and are quite peculiar in structure and appearance. They are simple and continuous, or sometimes pseudoseptate, and always connected with the cell that bears them by a characteristically constricted, usually blackened septum. They vary in shape from a mere bladder-like oval cell (fig. 20, Plate VI) to a more highly developed form, such as occurs in *P. curvata* (fig. 9). The appendages of the following genus, *Dichomyces*, are similar in all respects; but in no other case, with the exception of the species of *Chitonomyces* and its nearest allies do appendages occur having a similar appearance.

A single antheridium only is produced on one side from the sub-terminal member of the superposed cell-series. Their structure corresponds very closely to that of *Dimorphomyces*, ex-

cept that there appear to be not more than four antheridial cells (Plate II, fig. 12), which discharge into a common cavity above. The latter forms the slightly inflated base of the terminal conical portion of the organ, the antherozoids, which are comparatively minute, making their way through a pore at its apex.

The perithecia, except in *P. geminata*, are usually solitary, and arise normally from the distal cell-series; but in abnormal cases they may be produced externally from the sub-distal or even the lower series (*P. geminata*). In structure, the perithecia present no great peculiarities; the cell-rows containing each four cells, the lip-cells being usually characteristically papillate, and symmetrical or nearly so. The ascogenic cell is commonly solitary (Plate I, figs. 27–31); but in some instances there appear to be two. The trichogyne, in the few cases in which it has been observed, is very rudimentary, consisting of a vesicular prominence, sometimes showing a tendency to produce slight protuberances, as in the case of *Camptomyces*.

The four known species all occur on terrestrial beetles belonging to the Carabidæ and Staphylinidæ, and on account of their small size and appressed habit are usually detected with difficulty.

In the following descriptions the side which bears the antheridia is spoken of as the anterior, the opposite as the posterior face of the individual. The antheridium may thus be described as occurring on the left side.

PEYRITSCHIELLA CURVATA Thaxter. Plate II, fig. 12; Plate IV, figs. 11–18.

Proc. Am. Acad. Arts and Sci. Vol. XXIV, p. 8.

Perithecia hyaline, nearly straight, tapering to the symmetrically four-lobed apex, bent at an angle to the axis of the receptacle, the curvature of which it continues. Receptacle consisting of two superposed cells, followed by two transverse series of cells of variable numbers (four to seven); the terminal bearing one, rarely two, perithecia, with a group of sterile appendages on either side, the sub-terminal producing on one side, the sharply pointed antheridium with or without one or more adjacent sterile appendages; on the other side a group of from one to three similar appendages. Appendages simple, cylindrical, continuous, or pseudoseptate, hyaline, sometimes becoming tinged with brownish. Spores, $26 \times 3.5\text{--}4\ \mu$. Perithecia, $90\text{--}100 \times 22\text{--}29\ \mu$. Appendages (longer), $60\ \mu$. Total length to tip of perithecium, $280\text{--}300\ \mu$.

On *Platynus cincticollis* Say. Vicinity of New Haven, Conn., of Cambridge, Mass., and of Kittery Point, Maine.

The more common species of the genus occurring on the right shoulder of its host, and sometimes on the adjacent edge of the elytra. It is distinguished from the three remaining species by the absence of the lower transverse series of cells, the sub-basal cell of its receptacle remaining undivided at maturity. In very rare instances, two perithecia may be borne on a single individual; but I have seen but two cases of this kind among some dozens of specimens. The curved habit of the species is doubtless due to its position of growth upon the host, and is a character of little importance. The beetle on which it is found is common in the localities mentioned, along small brooks, where it may be found, concealed beneath stones, sticks, and rubbish generally, in shady places.

PEYRITSCHIELLA GEMINATA Thaxter. Plate IV, figs. 7-8 and 24.

Proc. Am. Acad. Arts and Sci. Vol. XXIX, p. 101.

Hyaline. Receptacle asymmetrical, consisting of a single basal cell followed by three successive, more or less definite, transverse rows of cells. The lowest of these rows is the most variable and irregular, consisting of from two to four cells, one of which, larger than the rest, is an axile cell continuing the basal cell directly, while the remaining one to three cells are cut off from it on one side, each successive cell smaller and placed higher in the series, the outermost and uppermost bearing one of the sterile appendages characteristic of the genus. The second row also consists of a larger median cell, which is free for a short distance on one side, and on both sides of which are cut off, as in the first row, from two to four cells, the smaller uppermost ones on both sides giving rise to from one to three appendages, according to the number of the cells. The upper row is either symmetrical or asymmetrical, according as it gives rise to two or to only one perithecium. In the first instance it consists of a median cell, above which are produced two sterile appendages, and a variable number of cells cut off laterally as in the lower rows, but nearly symmetrical in size and shape, the outermost bearing sterile appendages. If one perithecium only is produced, the row is asymmetrical, and a greater number of appendages appear on one side of the perithecium than on the other. Perithecia very slightly inflated near the base, tapering abruptly but slightly to the spreading apex, which is four-lobed, the lobes rounded, large and prominent. Spores about $37 \times 3.7 \mu$. Perithecia, $75-80 \times 18-22 \mu$. Total length to tip of perithecia, $220-260 \mu$ (150μ in specimens from the smaller host).

On *Pterostichus luctuosus* Dej., *P. erythropus* Dej., and *P. patruelis* Dej., Kittery Point, Maine; Arlington, Mass.

Unlike the other species, this form not infrequently produces two perithecia, the arrangement of its distal cells in such cases closely resembling that of *Dichomyces*. The main body of the receptacle is, however, asymmetrical, and the antheridium occurs only on one side.

It is distinguished from the preceding species by its more slender form, smaller and shorter appendages and perithecia, and especially by the division of the sub-basal cell of its receptacle to form an incomplete transverse series, or rather half-series, of cells. Its antheridium is small and inconspicuous, occurring on one side as in the other species. It may be found growing on the inferior surface of the prothorax near its anterior margin, and on the adjacent posterior margin of the prothorax, as well as on the anterior legs. In the last position the individuals become very considerably distorted in form, and in such specimens several instances have been observed in which perithecia were developed from the lower and middle transverse series of cells on the right side (opposite the antheridium).

The species is a rare one, though the hosts which it infests are not uncommon under stones or in rubbish near the margins of ponds or streams.

PEYRITSCHIELLA MINIMA Thaxter. Plate VI, figs. 19-21.

Proc. Am. Acad. Arts and Sci. Vol. XXIV, p. 266.

Hyaline or slightly yellowish. Perithecia somewhat asymmetrical, large, stout, tapering rather abruptly to the blunt apex, which terminates in four not very prominent, nearly symmetri-

cal papillæ. Receptacle stout, sub-triangular in form, consisting of a rather small, often slender, basal cell, followed by the usual three transverse series of cells. The lower of these consists of the median or primary cell, on one side of which a single small cell is cut off, while on the opposite side a series of four or more cells, mostly appendiculate, extend obliquely upward and outward, overlapping one another to some extent. The middle series consists of a large median cell, on either side of which numerous (four or more) appendiculate cells extend obliquely upward and outward, and produce, on one side, the large pointed antheridium, which does not usually project beyond the margin of the receptacle. The distal series, like the sub-distal, composed of fewer cells and bearing the single perithecium. Appendages oval or short cylindrical, becoming brownish; their basal septa large, but not conspicuously blackened. Spores, $37-40 \times 4 \mu$. Perithecia, $100 \times 33 \mu$. Appendages (longest), 33μ . Total length to tip of perithecium, $190-220 \mu$. Receptacle, $90-110 \times 50-58 \mu$.

On *Platynus cincticollis* Say. Vicinity of New Haven, Conn.; Weston, Mass.; York, Maine.

A rare species occurring near the extremity of the anterior legs of its host, where, owing to its compact form and small size, it is easily overlooked. It is very distinct from the two preceding species, and peculiar from its sub-triangular form, from the presence of cells cut off on both sides of the primary or median cell of the lower transverse series, and from the numerous short, inflated, bladder-like appendages. The latter are thickly clustered on the left margin of the receptacle, while the right presents an unbroken line from the foot nearly to its summit. The habitat of the host has been already mentioned under *P. curvata*, and both species have been found on a single individual.

PEYRITSCHIELLA NIGRESCENS Thaxter. Plate VI, figs. 22, 23.

Proc. Am. Acad. Arts and Sci. Vol. XXVIII, p. 184.

Receptacle sub-triangular in form, consisting of a single basal nearly hyaline cell followed by the usual three series, the lower broadly edged with black on either side, consisting of a long median cell from which three cells are cut off on the right and two on the left; the middle series of about ten cells, which form slight blunt appendiculate projections on either side, extending much higher on the left than at the right, where the single antheridium is situated; the upper series shorter than the middle, bearing the single stout, asymmetrical perithecium, on either side of which are several short appendages asymmetrically placed. Perithecia, $65 \times 19 \mu$. Receptacle, $70 \times 37 \mu$. Total length, 130μ .

On *Philonthus debilis* Grav. Waverly, Mass.

The single type from which the above description is drawn was found on one of the posterior legs of its host, the figures given representing an anterior and posterior view of the same specimen. The compact sub-triangular form of the receptacle and the stout perithecium connect it more closely with *P. minima* than with either of the other species; while the external blackening of its lower cell series suggests some of the species of *Dichomyces*. In its asymmetrical development and single antheridium, however, it corresponds exactly to the type structure of *Peyritschella*. The perithecium of the unique type is not quite mature, and more fully developed material may show that its apex becomes characteristically papillate as in the other species.

DICHOMYCES Thaxter. Plate VI, figs. 25-36; Plate VIII, figs. 11-14.

Proc. Am. Acad. Arts and Sci. Vol. XXVIII, p. 183.

Receptacle flattened, sub-triangular; consisting of a single basal cell followed by three transverse series of cells symmetrically placed; the distal row bearing a pair of perithecia symmetrically placed; or a single perithecium, the fellow of which is undeveloped, together with certain sterile appendages; the sub-distal row producing a pair of compound antheridia symmetrically placed and subtended by one or more sterile appendages. Perithecia symmetrical. Spores once septate. Appendages and antheridia as in *Peyritschiella*.

This genus, although very closely related to *Peyritschiella*, is distinguished by the bilateral symmetry which characterizes not only the arrangement of the cells of the receptacle itself, but of the organs produced from it, namely, the antheridia and perithecia; although in a single species (*D. inæqualis*) one perithecium only is developed, which is, however, placed symmetrically in relation to the cell from which, in the other species, a second perithecium arises. Apart from this bilateral symmetry, the structure and development of the members of the two genera are identical, and were it not for the fact that of the eight species included by them, four correspond exactly to one, and four to the other type, the two genera might readily be united. The four species of *Dichomyces* are among the most striking and curious in form of all the Laboulbeniaceæ. They have been found thus far only on beetles belonging to the Staphylinidæ, such as inhabit rather dryer situations, in most cases common among rubbish in cultivated fields.

In the following descriptions the face bearing the antheridia is spoken of as anterior.

DICHOMYCES FURCIFERUS Thaxter. Plate VI, figs. 25-29.

Proc. Am. Acad. Arts and Sci. Vol. XXVIII, p. 184.

Receptacle consisting of a small basal cell, which is nearly hyaline distally and suffused with brown basally, the receptacle above gradually expanding into a more or less fan-like form, the basal portion wholly black and opaque, the blackened area extending upward externally and including a prong-like projection with one or two appendages at its base, which extends above the base of the perithecium and forms the terminal portion of the sub-distal transverse series of cells on either side; the latter, seven in number, becoming generally suffused with blackish brown, the long rectangular median cell usually more or less distinct, the remainder partly or wholly opaque and indistinguishable; the antheridia lighter brownish. The distal row of cells seven in number, their septa straight, thin, and clearly defined; the middle cell of the series bearing distally two appendages, placed antero-posteriorly, the terminal cells of the series on either side also bearing two appendages, the inner slightly anterior. Perithecia bent slightly forward, tapering very slightly to the blunt apex, which bears a short, recurved, tooth-like projection on either side from each anterior lip-cell. The perithecia and distal row of cells faintly tinged with reddish purple. Appendages short, simple, hyaline, cylindrical, with a constricted blackish base. Perithecia, $63 \times 16-18 \mu$. Receptacle: length to base of perithecia about 90μ ; to tips of external projections, $100-120 \mu$; greatest width, $55-60 \mu$.

On *Philonthus debilis* Grav., Waverly, Mass., and Kittery Point, Maine.

A most singular plant looking like a two-pronged fork or a pair of inverted pincers, between the black arms of which arise the two perithecia. The lower portion of the receptacle is so opaque that the cell structure is indistinguishable; but, as far as it can be made out, the lower transverse series of cells consists of a long median cell, on either side of which two, perhaps three, cells are cut off in a fashion similar to that represented in the figure of *D. princeps* (Plate VIII, figs. 11-12). In the present, as well as in the remaining species, the appendages vary somewhat in number according to the number of terminal cells in the distal and sub-distal series, which is not quite constant; and, in the majority of individuals, but few of the appendages remain unbroken at maturity. Of the two appendages situated between the perithecia, one represents the original terminal appendage of the germinating spore. The general form of the receptacle is quite characteristic, and in the region of the distal series of cells it is distinctly concave on the anterior side, the posterior face being somewhat convex.

From the fact that its host is dark-colored, while the parasite itself is partly blackened, it is often very difficult to detect, lying, as it generally does, appressed against the surface of the former. It sometimes occurs, however, in such large numbers that it is seen without any difficulty, and in such cases, although it is usually found on the under surface of the abdomen, it may extend to the legs, thorax and all parts of the body of its host. Its natural position seems to be with the tip of the perithecium turned toward the extremity of the insect's body, and the anterior face turned inward, the perithecia being turned slightly backward (upward). Although the host is very common, this species, like its relatives in the genus, seems to be decidedly rare.

DICHOMYCES INÆQUALIS Thaxter. Plate VI, figs. 30-34.

Proc. Am. Acad. Arts and Sci. Vol. XXIX, p. 103.

Receptacle as in *D. furciferus*, its fork-like projections prominent and indistinctly septate, the distal row of cells bearing a single perithecium; otherwise symmetrical, except that the sub-median cell, above which a second perithecium arises in *D. furciferus*, is much reduced in size. Appendages ten to twelve, one external to and near the base of each antheridium, two above the median cell of the distal row, and three to four borne one from each of the three to four cells of the distal row external to the sub-median cells, all arising as in *D. furciferus*. Perithecium large, slightly inflated towards the base; or sub-cylindrical, tapering abruptly at the extremity to a sub-truncate apex destitute of appendages. Spores, $26 \times 3.5 \mu$. Perithecia, $100 \times 25 \mu$. Receptacle, length to base of perithecium, 92μ ; length to tips of lateral forks, $110-130 \mu$; greatest breadth, $50-60 \mu$. Total length to tip of perithecium, $180-190 \mu$.

On *Philonthus debilis* Grav. Kittery Point, Maine, and Waverly, Mass.

This species occurs, sometimes in company with *D. furciferus*, on the abdomen, more rarely on the legs and thorax of its host. It is at once distinguished by its solitary perithecium, which is destitute of the terminal outgrowths peculiar to the last named species. It is much more common in the localities mentioned than its ally, and in none of the numerous specimens examined does there appear to be any variation in the points of structure which distinguish it. In no instance was any attempt observed to produce the usual pair of perithecia, and the single perithecium, by its larger size, somewhat different form, and abruptly truncate apex, serves readily to distinguish it.

DICHOMYCES INFECTUS Thaxter. Plate VI, figs. 35-36.

Proc. Am. Acad. Arts and Sci. Vol. XXIX, p. 102.

Receptacle consisting of a short basal cell succeeded by an axile cell placed vertically, on either side of which a series of three obliquely superposed cells forms a blackened border. The remainder of the receptacle consists of two successive transverse symmetrical rows of cells, the lower row made up of three central and several smaller external cells, terminating on either side in a short, blunt projection below the prominent antheridia; beside which arise externally single sterile appendages. The distal row is composed of seven cells, the external cells on either side not extending beyond the bases of the perithecia and destitute of appendages; two appendages arise between the perithecia, one on either side. Perithecia two, closely approximated, arising from single broad, flattened cells, short and stout, tapering slightly toward the sub-truncate apex, which is destitute of papillæ or appendages. Perithecia, $66 \times 22 \mu$. Receptacle, $60 \times 40 \mu$.

On *Xantholinus obsidianus* Melsh. Waverly, Mass.

Two specimens of this small form were found at the tip of the abdomen of its host, only one of which is preserved as the unique type of this well-marked species. Its broad, stout perithecia, and the absence of any external appendages on the distal series of cells, distinguish it readily from other species. Although sought for diligently, it has been found but once, notwithstanding the fact that its host is a beetle common in cultivated fields, where it may be found running over freshly turned soil or concealed in decaying vegetable matter.

DICHOMYCES PRINCEPS Thaxter. Plate VIII, figs. 11-14; Plate II, fig. 11.

Proc. Am. Acad. Arts and Sci. Vol. XXX, p. 479.

Nearly hyaline, becoming slightly and uniformly tinged with pale reddish brown, sometimes narrowly edged with blackish near the base. Receptacle large, consisting of a single small squarish basal cell, above which are three successive transverse rows of cells placed side by side, the upper margin of each series convex; the lower series consisting of a long narrow axial cell, with three or four more or less obliquely superposed cells on either side; the middle series consisting also of an axial cell, with five to eight cells on either side, which extend obliquely upward and outward to form a free rounded projection, each cell of which bears a short appendage, the antheridia prominent at the base of each projection; the third or distal transverse series like the second, the cells often slightly more numerous, forming projections in a similar fashion on either side which bear the same short appendages. The axial cell of the terminal series is followed by two small cells, each bearing a short appendage, on either side of which a large somewhat flattened cell forms the base of the perithecium. Perithecia two, more or less divergent, elongate, slightly inflated and tapering rather gradually to the blunt apex. Perithecia, $110-165 \times 22-30 \mu$. Spores, $38 \times 4 \mu$. Receptacle, $150-180 \times 70-75 \mu$.

On *Philonthus sordidus* Grav. Waverly, Mass.

This fine species is by far the largest and most conspicuous member of the genus, and, owing to the absence of any deeply blackened portions, illustrates the typical form more clearly

than any of its allies. I have met with it on one occasion only, when several hosts were collected from a heap of rubbish near cultivated land, on which the parasite occurred in great numbers, thickly covering the lower surface of the abdomen and extending to the legs and thorax. Unfortunately, all but one of these hosts made their escape in transit, but the single one remaining has furnished abundant material of the mature form. Owing to its light color, large size, and more than usually divergent, though not erect, habit of growth, it is not readily overlooked on the black abdomen of its host.

CHITONOMYCES PEYRITSCH, Plates VIII and XXVI.

Sitz. d. k. Acad. d. Wiss. LXVIII, p. 250 (1873); *HEIMATOMYCES* PEYRITSCH, l. c. p. 251; *HEIMATOMYCES* EMEND., Thaxter. Proc. Am. Acad. Arts and Sci. Vol. XXVII, p. 30.

Receptacle consisting of a basal and a terminal portion; the former consisting of two superposed cells, and three or four upper smaller cells which form the base of the perithecium; the latter consisting of four cells lying beside the perithecium, the terminal cell always free, originally more or less dome- or bell-shaped, bearing a single terminal appendage, and sometimes becoming otherwise modified at maturity; the sub-terminal cell connected on its inner side with, or rarely free from, the two cells below it, from the upper of which is separated a small cell that bears terminally, in the angle formed by the perithecium and the receptacle, one or two appendages, beside which is situated the usually small antheridium (?). Appendages slender, filamentous, simple, aseptate or spuriously septate, hyaline, evanescent, the base blackened and slightly constricted. Perithecium more or less completely united to the distal portion of the receptacle, each series of wall-cells containing not more than six cells, some of which may be appendiculate; the apex often variously modified. Spores fusiform, once septate.

Since the description of numerous species under the name *Heimatomyces*, I have had an opportunity of examining specimens of *Chitonomyces melanurus* Peyritsch, and, as I formerly suggested, the two genera prove identical. I have therefore concluded to use the latter name to distinguish the genus; since, although I very much dislike to regard the rules of priority at the expense of those of common sense, it seems desirable that the nomenclature adopted in the present monograph should be, in so far as possible, a fixed one, and the name *Chitonomyces* undoubtedly has precedence in the present instance to the extent of nearly half a page.

The genus is one the position of which has been, until the present paper was in press, quite uncertain; the character of the sexual organs not having been ascertained with sufficient exactness to warrant any definite statement concerning them. The very recent discovery, however, of an undescribed and very closely allied aquatic genus, in which the antheridium is so placed that it can be readily seen, renders its position no longer doubtful, and confirms my first impression, which was based on the general resemblance of its appendages and the structure of its receptacle to those of *Peyritschella*. The new genus, a description of which is necessarily reserved for a succeeding supplement, is characterized by a general structure curiously intermediate between that of *Chitonomyces* and the genus last mentioned, the small but very definite compound antheridium occupying a position on the anterior margin of the plant just below the base of the perithecium.

In the present genus, the antheridium, or what I have taken to be that organ, lies just beside the bases of the lower appendages, and has not been satisfactorily made out, owing to the small size and lack of definition in the cells lying in this region. In *C. rhyncostoma*, what appears to be the neck of the antheridium becomes enlarged, as the individual matures, and projects as a conspicuous hook-like prominence from the angles between the perithecium and the appendage (Plate XXVI, fig. 18). The character of the trichogyne is also a matter of uncertainty, and although I have definitely made out the carpogenic and trichophoric cells, the latter terminating close beside the supposed antheridium, I have been quite unable to determine whether one of the two "appendages" was in reality a trichogyne or whether, as is more probable, the latter is reduced merely to a slightly inflated prominence. Owing to the minute size of a majority of the species, and the difficulty in obtaining material of young individuals, the determination of these matters is by no means easy, and involves an expenditure of time that I have been unable to afford.

In other respects the structure of the members of the genus is well defined and remarkably constant; although the perithecium is subject to curious variations of form, and the terminal portion of the receptacle, especially its terminal cell, is often so modified as to obscure its true structure. In *C. melanurus*, for example, the terminal and the sub-terminal cells are, at maturity, opaque and indistinguishable, the former becoming proliferous below its original apex and developing a hook-like extremity, the insertion of the originally terminal appendage being turned to one side, and visible only as a slight prominence from its inner margin (Plate XXVI, fig. 19). A somewhat similar modification is seen in *C. marginatus*, in which the whole distal portion of the receptacle becomes blackened, and the terminal cell is similarly proliferous (Plate XXVI, figs. 20 and 21; Plate VIII, fig. 27). The curious outgrowths from the wall-cells of the perithecium are remarkable from the fact that they are not confined to any special cell or even cell-series, being quite variable in position, as in *C. paradoxus*, *C. appendiculatus*, *C. spinigerus*, *C. uncinatus* and others. The appendages closely resemble those of *Peyritsiella*, and are very slender and evanescent, being usually completely broken off in mature specimens, the blackened bases alone remaining. The more or less dome-like cell which bears the terminal appendage is identical with the similar cell which bears this appendage in the last-mentioned genus.

Reference has already been made to the form of the foot, which is peculiar to this and the succeeding genus, and seems undoubtedly designed to allow a greater freedom of motion necessitated by the exigencies of life in the water on a rapidly moving host. The base of the foot, by which alone it is attached to the host, is rather narrow and pointed, while the upper portion is more or less rounded, and serves as a fulcrum on which the individual may roll from side to side through a considerable arc. The remarkable constancy with which the different species occur in definite positions has also been previously alluded to (p. 246); and, as will be seen, is practically invariable in every instance. All the species are aquatic, and are, so far as known, confined to hosts belonging to the family Dytiscidæ.

As in previous instances, the side bearing the perithecium is considered anterior, the lower appendages are thus described as arising from the left side. It may be remarked in passing that species credited to Connecticut only are undoubtedly as widely distributed as the others, this being the only locality in which they have been carefully sought for.

CHITONOMYCES PARADOXUS (Peyritsch). Plate VIII, figs. 17-21.

HEIMATOMYCES PARADOXUS Peyritsch, Sitz. d. k. Acad. d. Wissen. Bd. LXVII, p. 251; Wien, 1873, Plate III, figs. 35-39; Winter, Die Pilze Deutschl. II, p. 525, p. 920, fig. 5; Sorokin, Veg. Par. of Man, etc., p. 425, Plate XXXII, figs. 763, 770; Saccardo Sylloge, Vol. VIII, p. 915; Berlese, Malpighia, Vol. III, p. 60; Thaxter, Proc. Am. Acad. Arts and Sci. Vol. XXVII, p. 32.

Pale straw color becoming tinged with amber brown. Perithecium asymmetrical, the irregular lip-cells lateral and internal, the sub-terminal wall-cells of one of the external series produced to form a pointed terminally curved outward horn-like projection; a prominent ridge extending transversely on the left side from about the centre of the perithecium across the sub-terminal cell of the receptacle. Receptacle of the usual form, the basal cell large, the sub-basal cell flattened, the terminal and sub-terminal cells projecting almost wholly free beside the perithecium. Spores strongly curved, fusiform, $65 \times 7 \mu$. Total length to tip of perithecial horn about 225μ ; to tip of receptacle, $150-185 \mu$. Greatest width, $60-75 \mu$.

On *Laccophilus maculosus* Germ., New England; on *Laccophilus* sp., Kansas (Barber); on *L. minutus* Sturm., and *L. hyalinus* Dej., Europe (Peyritsch).

This species, which is the largest of the genus, occurs invariably on the outer margin of the left elytron, somewhat beyond the middle, where it grows in groups of from two to half-a-dozen, and is very easily seen from its large size. It is not uncommon, and is not to be confused with any other species from the terminal, horn-like outgrowth of its perithecium.

CHITONOMYCES APPENDICULATUS Thaxter. Plate XXVI, figs. 25-26.

HEIMATOMYCES APPENDICULATUS: Proc. Am. Acad. Arts and Sci. Vol. XXVII, p. 31.

Becoming faintly brownish. Perithecium tapering to a rather sharp apex, curved strongly outward, hunched externally and bearing a straight, sub-clavate, one-celled, brownish appendage arising externally some distance below the apex, projecting outward and upward at an angle of about 45° . Basal cell of the receptacle rather narrow, twice as long as the squarish sub-basal cell. Spores, $32 \times 3 \mu$. Perithecia, $55 \times 15 \mu$ to $75 \times 22 \mu$. Basal and sub-basal cells, $30-45 \mu$ in length. Perithecial appendage, $30-33 \times 4 \mu$. Total length to tip of perithecium, $100-130 \mu$. Greatest breadth, $30-36 \mu$.

On *Laccophilus maculosus* Germ., Connecticut.

A rare species, confined to the anterior pair of legs of its host, and distinguished at once by its clavate perithecial appendage, which corresponds to the similar horn-like projection from the perithecium of *C. paradoxus*, but is very different in form and in its relation to the other parts of the perithecium.

CHITONOMYCES DISTORTUS Thaxter. Plate XXVI, figs. 29-30.

HEIMATOMYCES DISTORTUS: Proc. Am. Acad. Arts and Sci. Vol. XXX, p. 477.

Pale yellowish, more or less clavate in general form. Perithecium inflated, its external margin strongly curved, becoming abruptly constricted below a long, slender, tubular, terminal

mouth, which is usually, but not always, bent abruptly outward almost at right angles to the nearly straight inner margin of the perithecium. A short, straight, bluntly-pointed, rather stout appendage arises on one side only of the perithecium, just below this tubular apex beyond which it projects. The basal and sub-basal cells of the receptacle about equal in length, the latter broader: distal portion of the receptacle composed of the usual four cells, the sub-terminal cell forming a distinct external prominence below the terminal cell, which is bent toward and partly overlaps the perithecium. Perithecium (main body), $60 \times 18 \mu$, its tubular apex, $18-25 \times 6 \mu$. Spores, $20 \times 3 \mu$. Length of receptacle, 110μ .

On *Laccophilus maculosus* Germ., Connecticut.

A singular species appearing at first sight malformed or abnormal. It occurs in company with *C. appendiculatus* on the anterior legs of its host, and is at once recognized by the tubular prolongation of the apex of its perithecium.

CHITONOMYCES SPINIGERUS Thaxter. Plate VIII, figs. 15-16.

HEIMATOMYCES SPINIGERUS: Proc. Am. Acad. Arts and Sci. Vol. XXX, p. 478.

Brownish yellow. Perithecium small, its tip slightly exceeding that of the receptacle; its extremity blunt, lobed, curved outward, and bearing two projections unequal in size just below the tip, one of which extends outward beyond the perithecial margin as a blunt prominence. Basal cell of the receptacle often bent, expanding distally, much longer than the flattened sub-basal cell: the distal portion of the receptacle with greatly thickened external walls, and consisting of the usual four cells, the terminal one short, with a broad base and bent towards the apex of the perithecium. Three small cells are distinct below the perithecial cavity, from the outer of which is produced externally a prominent spur-like process. Perithecia, $55 \times 15 \mu$. Total length to tip of perithecium, $88-90 \mu$. Spur-like process, $12-30 \mu$ long.

On *Laccophilus maculosus* Germ., Connecticut.

Distinguished from all other species by the spur-like process from the base of the perithecium. The septa are all defined with unusual clearness, the external walls being greatly thickened. Apparently among the rarest of the twelve species inhabiting this host.

CHITONOMYCES UNCIGERUS Thaxter. Plate XXVI, figs. 27-28.

HEIMATOMYCES UNCIGERUS: Proc. Am. Acad. Arts and Sci. Vol. XXX, p. 478.

Pale yellowish. Perithecium moderate, rather broad, its outer edge straight, its upper fourth free from the receptacle, its prominent bluntly-tipped extremity bent abruptly outward at right angles: a slender hooked appendage arises from a point close to the receptacle about two-thirds of the distance from the base to the apex of the perithecium, projecting from it obliquely outward. Basal cell of the receptacle large and long, the sub-basal cell small, sub-rectangular, flattened: the distal portion composed of the usual four cells, the terminal one not very prominent, and bent strongly toward the perithecium. Perithecia, $80 \times 22-25 \mu$. Spores, $45 \times 4 \mu$. Perithecial appendage about 22μ long. Receptacle, 132μ long. Total length to tip of perithecium, 135μ .

On *Laccophilus maculosus* Germ., Connecticut.

The more or less wedge-shaped apex of the perithecium of this very distinct form projects outward abruptly at right angles to the straight outer perithecial margin. The hook-like appendage is quite unlike that of any other species in form and position, and, occurring only on one side, is not seen unless the perithecium lies at the right. It occurs with *C. spinigerus*, *C. hyalinus*, and rarely *C. marginatus*, on the posterior legs of its host.

CHITONOMYCES MELANURUS Peyritsch. Plate XXVI, fig. 19.

Sitz. d. k. Acad. d. Wissen., Bd. LXVII, p. 251, Plate III, figs. 30-34; Wien, 1873; Winter Die Pilze Deutschl., Bd. II, p. 924, p. 920, fig. 4; Sorokin, Veg. Par. of Man, etc. Vol. II, p. 424, Plate XXXII, fig. 771; Saccardo Sylloge, Vol. VIII, p. 914; Berlese, Malpighia, Vol. III, p. 59.

Straw colored, becoming faintly brownish. Perithecium slightly inflated near its base, its sub-terminal wall-cells expanded to form a projection from the outer and inner margin, each of which extends a little beyond the small hyaline apex which lies between them; the outer projection smaller and distinctly brownish, the inner nearly twice as broad and hyaline. The two lower cells of the receptacle nearly equal, forming a rather slender basal portion, above which it expands somewhat abruptly: the terminal and sub-terminal cells deeply blackened, the latter proliferous externally below the insertion of the appendage, which is thus turned inward, and becomes lateral in position, the proliferation extending some distance beyond it, and forming a terminal, translucent, outwardly turned hook. Length of perithecium, 95-100 μ . Total length to tip of perithecium about 150-160 μ ; to tip of receptacle, 145-150 μ . Greatest width, 30-35 μ .

On *Laccophilus minutus* Sturm. and *L. hyalinus* Dej., Europe.

This peculiar species, which is the type of the genus, does not appear to occur in this country, its place being taken curiously enough by the succeeding species, which occurs in exactly the same position often in company with *C. paradoxus*, and exhibits a somewhat similar proliferation of the terminal cell of the receptacle. The material from which the accompanying figure and description were derived was found on a specimen of *Laccophilus* from Germany in the collection of the Museum at Cambridge. Although Peyritsch placed it in a genus distinct from *C. paradoxus*, there is no doubt whatever as to the generic identity of the two forms.

CHITONOMYCES MARGINATUS Thaxter. Plate XXVI, figs. 20-22; Plate VII, figs. 25-27.

HEIMATOMYCES MARGINATUS: Proc. Am. Acad. Arts and Sci. Vol. XXVII, p. 34.

Long and slender, at first nearly hyaline, then yellowish. Perithecium straight, then suddenly bent inward below the hyaline, neck-like, strongly curved tip. Basal cells of the receptacle sub-triangular, the sub-basal half as large as the basal, the three cells at the base of the perithecium more than usually developed: the terminal cells all becoming black and opaque at maturity; the terminal one continued by a squarish outgrowth basally hyaline, at first lateral and external, becoming terminal (the true apex of the cell being pushed inward and becoming lateral), hardly exceeding the tip of the perithecium, which it conceals. Spores, $30 \times 3 \mu$. Perithecia, 95-110 \times 22 μ . Total length to tip of perithecium, 140-160 μ . Basal cells of receptacle, 25 μ .

On *Laccophilus maculosus* and *Hydroporus spurius*, Connecticut, Maine; *Laccophilus* sp., Kansas, Barber.

A form peculiar for the modification of the terminal cells of the receptacle, which makes the perithecium appear as if bordered by a black band. It is found in company with *C. paradoxus*, and recalls in some respects the preceding species, which is similarly associated on the left elytron of its host. In one instance a few specimens were found on the left posterior leg, but such a position is exceptional.

CHITONOMYCES RHYNOSTOMA Thaxter. Plate XXVI, figs. 17-18.

HEIMATOMYCES RHYNOSTOMA: Proc. Am. Acad. Arts and Sci. Vol. XXVII, p. 33.

Evenly suffused with dull amber-brown. Perithecium relatively large, the broad extremity abruptly hooked inward, so that the papillate apex becomes lateral and internal; the external series of wall-cells prominent with conspicuous septa. Basal cell of the receptacle rather short, somewhat inflated; the sub-basal cell much flattened; the terminal and sub-terminal cells about equal in length, forming together an outwardly-curved, finger-like projection, exceeding the perithecium: a short but rather conspicuous hook-like structure (antheridium?) arises from the angle between the perithecium and the receptacle on the left side. Spores, $26 \times 3 \mu$. Perithecia, $75 \times 22 \mu$. Total length to tip of perithecium, 100μ . Basal portion of receptacle, $25-30 \mu$ long.

On *Laccophilus maculosus* Germ., and *Hydroporus spurius* Lec., Connecticut.

This species occurs rather rarely on the margin of the right elytron in a position corresponding to that occupied by *C. paradoxus*, but nearer to the middle. The broad hooked apex of the perithecium, coupled with the finger-like development of the distal portion of the receptacle, serve at once to distinguish it from known species. The hook-like projection, which arises near the base of the lower appendages, has already been alluded to in the previous description of the genus, and may be the antheridium.

CHITONOMYCES LICHANOPHORUS Thaxter. Plate XXVI, figs. 15-16.

HEIMATOMYCES LICHANOPHORUS: Proc. Am. Acad. Arts and Sci. Vol. XXVII, p. 32.

Hyaline except for the suffused basal cell. Perithecium bent outward at an angle from the basal part of the receptacle, tapering slightly to the papillate apex. Basal cell of receptacle enlarged and greatly elongated, more or less intensely blackened above its hyaline base; sub-basal cell flat and almost obsolete. Terminal and sub-terminal cells together forming a straight, finger-like projection as long as or longer than the perithecium, on which the appendage is terminal. Spores, $33-37 \times 2.5-3 \mu$. Perithecia, $65-90 \times 30 \mu$. Total length to tip of perithecium, $150-180 \mu$. Basal cell, $90-110 \mu$.

On *Laccophilus maculosus* Germ., Connecticut.

This species is confined to the median inferior anal plate of its host, and has only been observed upon males. It is not to be confused with any other species, being distinguished by its elongated basal and apical cells, almost black and white color, and papillate divergent perithecium. *C. rhynostoma*, which has a very similar finger-like prolongation of the terminal portion of its receptacle, is at once separable by the basal cell, and the form of its perithecium.

CHITONOMYCES UNCINATUS Thaxter. Plate XXVI, fig. 23-24.

HEIMATOMYCES UNCINATUS: Proc. Am. Acad. Arts and Sci. Vol. XXVII, p. 33.

Evenly suffused with pale amber-brown. Perithecium large, curving evenly inward to the somewhat pointed apex. Basal cells of the receptacle rather slender, the terminal cell pushed to one side and bent past the apex of the perithecium by a somewhat indurated, blunt outgrowth from the sub-terminal cell, the tip of which it nearly equals. Perithecia, $75-85 \times 20 \mu$. Total length, $110-130 \mu$. Basal cells of receptacle, 37μ .

On *Laccophilus maculosus* Germ., and *Hydroporus spurius* Lec., Connecticut.

A rather rare species, occurring in groups on the inferior surface of the abdomen of its host, and distinguished by the peculiar development of the sub-terminal cell of the receptacle, which gives its extremity a somewhat hooked appearance.

CHITONOMYCES AFFINIS Thaxter. Plate XXVI, figs. 12-14; Plate VIII, figs. 29-30.

HEIMATOMYCES AFFINIS: Proc. Am. Acad. Arts and Sci. Vol. XXVII, p. 31.

Rather strongly suffused with amber-brown. Perithecium commonly slightly curved inward, or nearly straight, the tip often slightly bent outward. Basal cell of receptacle large, sub-triangular, suffused laterally and terminally with deep black-brown: sub-basal cell very flat; terminal cell small, its axis bent strongly inward. Spores, $50-55 \times 3 \mu$. Perithecia, $100-110 \times 30 \mu$. Basal and sub-basal cells of receptacle, $40-45 \mu$. Total length to tip of perithecium, $150-170 \mu$.

On *Laccophilus maculosus* Germ., and *Hydroporus* sp., Connecticut.

This species occurs near the margin of the right elytron toward its tip, and is distinguished from other species of the more simple forms by its large, blackened basal cell and the position of the terminal cell of the receptacle, which is bent against the perithecium on the left side, and is partly concealed by it when viewed from the right. It is one of the commonest species, and is easily detected from its dark color.

CHITONOMYCES HYALINUS Thaxter. Plate XXVI, figs. 10-11.

HEIMATOMYCES HYALINUS: Proc. Am. Acad. Arts and Sci. Vol. XXVII, p. 31.

Hyaline or very faintly tinged with yellowish brown. Perithecium large; at first hunched externally and bent inward near the apex; at maturity becoming nearly straight, tapering slightly to the rather narrow apex, which is bent somewhat abruptly outward; one or two oblique ridges more or less distinct below the apex on the inner margin, the walls of the cells composing the outer margin greatly and often very abruptly thickened below the tip. Basal portion of the receptacle rather short and stout, the two lower cells nearly equal. Spores, $30 \times 2.5 \mu$. Perithecia, $75-90 \times 20 \mu$. Total length to tip of perithecium, $110-120 \mu$.

On *Laccophilus maculosus* Germ., Connecticut.

This species, although it possesses few striking characteristics, is yet quite distinct from any of the others, its chief peculiarity consisting in the fact that the walls of the cells composing the

outer margin become abruptly thickened below the tip. The oblique ridges, which are often very distinct below the apex on the inner side, and the abrupt outward curvature of the latter at maturity serve also to separate it from other known species. It is rather rare and detected with some difficulty.

CHITONOMYCES SIMPLEX Thaxter. Plate XXVI, figs. 1-3.

HEMATOMYCES SIMPLEX: Proc. Am. Acad. Arts and Sci. Vol. XXVII, p. 30.

Pale yellowish or faintly brownish. Perithecium rather slender, continuing the strong curve of the receptacle evenly outward to its rather coarse blunt straight tip. Basal cell of the receptacle much longer than the flattened sub-basal cell: terminal cell bell-shaped, small, the whole distal portion of the receptacle evenly curved parallel to the perithecium. Spores, $26 \times 11 \mu$. Perithecia, $55-60 \times 11-12 \mu$. Length of receptacle, 75μ . Basal cell, $15 \times 7.5 \mu$. Total length, $90-100 \mu$.

On *Laccophilus maculosus* Germ., *Hydroporus spurius* Lec., Connecticut.

A common species, occurring in considerable numbers on the elytra of the host, near the middle of the distal portion, possessing the simple typical structure of the genus, and distinguished by its evenly curved habit, and the prominent blunt almost cylindrical terminal portion of the perithecium.

CHITONOMYCES BIDESSARIUS Thaxter. Plate XXVI, figs. 4-5.

HEMATOMYCES BIDESSARIUS: Proc. Am. Acad. Arts and Sci. Vol. XXVIII, p. 185.

Hyaline, becoming faintly tinged with blackish. Perithecium small, stout, its upper third or fifth free from the receptacle, the apex bent outward, the basal portion straight, the tip broad, with large, prominent lips. Receptacle stout, the two basal cells more nearly equal, the two cells above these longer than broad and nearly equal; distal portion nearly as in *C. borealis*, the base of the short terminal cell horizontal. Perithecia, $40-48 \times 15 \mu$. Receptacle, 65μ long. Total length to tip of perithecium, 80μ .

On *Bidessus granarius* Aube, Kittery Point, Maine.

This is among the smallest of all the Laboulbeniaceæ, and though presenting no great peculiarities, is distinguished by its stout form as well as the short and very broad but not abruptly distinguished tip. It occurs in various positions on the upper surface of the elytra of its minute host.

CHITONOMYCES BOREALIS Thaxter. Plate XXVI, figs. 8-9.

HEMATOMYCES BOREALIS: Proc. Am. Acad. Arts and Sci. Vol. XXVIII, p. 185.

Hyaline or slightly yellowish. Perithecium large and stout, its distal half or more free from the receptacle, tapering slightly to the large blunt apex. Sub-basal cell of the receptacle small and flattened: the distal portion of the receptacle composed of only three cells (the fourth obsolete or very minute), the distal one large, longer than broad, its base very oblique, the two others very long and sub-triangular, the septum between them running obliquely from the insertion of

the "trichogyne" nearly to the base of the inner cell. Perithecia, $80-90 \times 22 \mu$. Receptacle, total length, $75-80 \mu$; length to tip of perithecium, $110-120 \mu$.

On *Desmopachria convexa* Aube, Kittery Point, Maine, and New Haven, Connecticut.

This species differs from those previously described by the apparent absence of the fourth cell in the distal portion of the receptacle. It is related to the preceding species in its cell arrangement, but is easily separated by its greater size, the relative position and shape of the perithecia, etc. The ascogenic cell faces outward, a position which seems exceptional. It is apparently rare, and occurs in small numbers on the anterior legs of its host.

CHITONOMYCES AURANTIACUS Thaxter. Plate XXVI, figs. 6-7.

HEIMATOMYCES AURANTIACUS: Proc. Am. Acad. Arts and Sci. Vol. XXIX, p. 103.

Pale straw-colored, the cell contents including numerous rather bright orange granules or oil globules. Perithecium exceeding the tip of the receptacle by from one-fifth to one-quarter of its length, small, slender, the tip usually curved outward, the lips rather prominent, its external basal cell marked by more or less distinct and very fine transverse ridges. Receptacle slender, the basal cell suffused with brown below, the sub-basal cell small and flat, the two succeeding cells elongate, the outer shorter and continued above by an unusually large basal cell of the perithecium: distal portion of the receptacle, as in *C. borealis*, composed of three cells, the two lower very long and narrow, sub-triangular, obliquely superposed, their lower extremities nearly touching the sub-basal cell. Perithecium, $50 \times 14-15 \mu$. Total length to tip of receptacle, $85-90 \mu$; to tip of perithecium, $100-110 \mu$. Greatest breadth, 22μ .

On *Desmopachria convexa* Aube, Kittery Point, Maine.

A rare species occurring on the right elytron near the middle of its distal half. Distinguished from *C. borealis*, which occurs also very rarely on the same host, and *C. Bidessarius*, by its slender form and orange color as well as the details of its structure. It is a very delicate species, seldom found in good condition. The striation of the outer basal cell of the perithecium is very characteristic, but not always distinct.

HYDRÆOMYCES nov. gen. Plates XXVI and VIII.

Receptacle consisting of a basal and terminal portion, the latter united to the perithecium along its inner margin and terminating in a sub-conical, terminally appendiculate free cell, the cell below the sub-terminal cell producing from its left face three outgrowths, which extend upward, and are separated as cells, ending like the terminal cell in a sub-conical body bearing a single terminal appendage and almost completely concealing the face of the sub-terminal cell: the basal portion consisting of three superposed cells, above which three or perhaps four cells form the base of the perithecium. The wall-cells of the latter arranged in four longitudinal series, each of which contains more than six (eight) cells. Spores fusiform, once-septate.

In view of the invariable character of the fundamental cell structure and arrangement in the sixteen species composing the genus Chitonomyces, to which the single form included by the present genus was first referred, and the very distinct variations from this type presented by

the latter, I have concluded to separate it, basing the new genus on the greater number and different arrangement of the small appendiculate cells bearing the lower appendages, the different number of wall-cells in the perithecium and the fact that three of the lower cells of the receptacle are superposed. The genus *Chitonomyces*, although so closely allied, shows no variation in these respects. The relation of the mature perithecium to the insertion of the trichogyne, and the considerable growth of the former beyond it, recalls the similar relation existent in *Ceratomyces*, while the same is true to a less degree in *Chitonomyces*. Although these three genera are all aquatic, it does not seem probable that the similarity just referred to indicates any close relationship with *Ceratomyces* in view of the very different character of the male organs in either case.

As in *Chitonomyces*, material has been lacking for a proper study of the younger stages of development, and the character of the trichogyne and antheridium has not been made out. In one specimen the procarpe was distinctly seen, and an attempt was made to represent it in fig. 24, Plate VIII. The trichophoric cell here was large and slightly inflated, lying close beside the inner appendiculate cell. The septation in this figure is somewhat misleading from the fact that it does not represent what is visible in a single plane.

There seem to be at least two if not more ascogenic cells in the mature perithecium, but their structure and early development have not been seen. It is needless to say that both these genera are in a most unsatisfactory condition in so far as concerns their development, and were it not for the discovery of the new genus above mentioned as intermediate between *Chitonomyces* and *Peyritschella*, their position would be entirely uncertain. The single form inhabits species of two genera of aquatic beetles belonging to a family (*Halipidæ*) no other members of which are known to be attacked by *Laboulbeniaceæ*.

HYDRÆOMYCES HALIPLI Thaxter. Plate XXVI, figs. 31-33; Plate VIII, figs. 22-24.

HEIMATOMYCES HALIPLI: Proc. Am. Acad. Arts and Sci. Vol. XXVII, p. 32.

Strongly suffused with dull amber-brown. Perithecia rather evenly inflated, the extremity evenly rounded, the lip-cells forming a flat, hyaline, abruptly projecting terminal papilla. Basal cell of the receptacle rather long, tapering below, its base suffused with blackish, the two cells superposed above it broader than long, nearly equal: the terminal cell more or less conical, the three lower appendiculate cells nearly as large as the terminal one, and almost completely hiding the sub-terminal cell on the left side. Spores, $30 \times 3 \mu$. Perithecia, $100 \times 35-40 \mu$. Total length to tip of perithecium about 150μ .

On *Haliphus ruficollis* DeG., and *Cnemidotus muticus* Lec., New Haven, Connecticut, and Kittery Point, Maine.

This species seems by no means common, and is found usually on the right elytron of its host or on the legs. A single specimen only has been found on *Cnemidotus*.

AMORPHOMYCES Thaxter. Plate V, figs. 17-29.

Proc. Am. Acad. Arts and Sci. Vol. XXVIII, p. 158.

Sexual organs borne on separate individuals.

Male individual. Receptacle consisting of two superposed cells, the upper bearing terminally a single simple antheridium.

Female individual. Receptacle consisting of a single cell, above which four (?) small cells form the base of the solitary terminal perithecium. Spores continuous. Asci four spored. Ascogenic cell solitary. Trichogyne a nearly sessile vesicle with short radiate branches.

The above description is based on the characters of the single species *A. Falagriæ*, since it is quite certain that the second supposed species, *A. floridanus*, is generically distinct and not even nearly related to it. The genus is among the most interesting of the whole group, not only from the fact that the sexes are separated on different individuals, but from the peculiarities of its development. It is the only form in which the perithecium is a strictly terminal structure, and, unless it be *Dimorphomyces*, no other genus has a unicellular receptacle.

The general development of the female is indicated by figures 20-23, the latter showing the first two septa which form in the germinating spore, dividing it into three superposed cells. Of these the lower, which may become partly divided, forms the unicellular receptacle; while of the two others the middle one (*c*) constitutes the primordial cell of the perithecium proper and the upper gives rise to the procarpe.

The development of the male individual is extremely simple. As in the case of the female the spore first divides (fig. 23 at the right) into three superposed cells. Of these three cells the two lower remain unchanged, and may be called the receptacle; although, from analogy with the female, one might infer that the middle cell was morphologically a basal cell of the antheridium. The terminal cell then elongates, producing a long tubular neck through which the antherozoids formed in its basal portion make their escape (fig. 20, at the right).

The spores are unique from the fact that even when fully mature they show no signs of septa; and their contents are exceptional in containing a number of large oil globules (fig. 29). They are always discharged in pairs, the members of which thus develop side by side. It is also an invariable rule, the existence of which has been established by very numerous observations, that, of the members of any such spore pair, one always produces a male and the other a female. Even at the time of discharge there often is observable a slight difference in the size of the two spores (fig. 29), the spore at the left in the figure being somewhat smaller than its fellow. As soon as germination commences (fig. 23) the difference becomes very apparent, and the course of development results which has just been indicated. When the female individual is mature, if care is taken in removing it from its point of attachment, it will always be found that a male individual is attached close to its base, the feet of the two individuals being adherent (fig. 17). A similar juxtaposition of the sexes at the point of growth has already been noted in connection with *Dimorphomyces*.

The trichogyne bears a striking resemblance to that of the last mentioned genus, and in some instances its radiating branches are furcate, as in fig. 24. The base of the trichogyne, as in the case of *Stigmatomyces* which has been described in detail elsewhere, is formed from a small cell

that becomes separated from the end of the trichophoric cell, and corresponds to the indurated portion of the trichogyne described in connection with *Camptomyces*. From this cell the receptive portion of the trichogyne first makes its appearance as a minute papilla, which enlarges and grows out to form the characteristic branches just described.

The development of the perithecium proper has not been followed out in all its details, but seems to correspond closely to that described as typical in the first part of this Memoir. Whether there is a stalk-cell and a secondary stalk-cell has not been determined, but it is probable that one of the two may be absent, since there seem to be but four cells about the base of the perithecium.

I have also been unable to observe the first divisions which take place in the carpogenic cell after fertilization, and it is only after the asci have begun to bud from the ascogenic cell that the interior of the perithecium can be seen with sufficient clearness to determine the nature of the changes which are taking place. At this period, however, the ascogenic cell becomes very distinct, and from its large size is a very good subject for observation. Although it is very long and there is sometimes an indication of a septum across it, its development appears to be identical with that of other cases already described. Its period of activity does not seem, despite its unusual size, to be as great as that of most ascogenic cells; and it is in this genus only that one is very apt to find individuals which have apparently died after completing their period of natural activity.

As in *Dimorphomyces*, instances sometimes occur in which the spores, not having been discharged for some reason, begin to germinate within the perithecium; and specimens like that represented in fig. 19 are not of very rare occurrence, the blackened foot in such instances being conspicuously developed, as well as faint indications of the three primary septa; but no case of almost complete development like that mentioned in *Dimorphomyces* (fig. 1) has been observed in the present instance.

The affinities of this very important genus are very obscure. From the character of its antheridium it would be placed in a different group from *Dimorphomyces*, which occurs on the same host and possesses an antheridium of the compound type very highly developed; yet in some respects it seems to approach this genus as closely as any other. The two genera are often found together on the same host, which is a very small beetle belonging to the *Staphylinidæ*.

AMORPHOMYCES FALAGRÆ Thaxter. Plate V, figs. 17-29.

Proc. Am. Acad. Arts and Sci. Vol. XXVIII, p. 158.

Male individual consisting of three superposed cells, the basal and sub-basal about equal, the latter suffused with dark brown, the suffusion often extending to the adjacent cells; the distal cell an antheridium, basally slightly inflated, distally prolonged into a cylindrical neck bent to one side. Total length, 48μ by 10μ broad.

Female individual. Receptacle hyaline, consisting of a small basal cell, sometimes partly divided, surmounted by usually three small cells more or less irregular in shape and position, which form the base of the large pale brownish yellow perithecium, which is curved strongly on the side opposite the ascogenic cell, and tapers to a blunt almost truncate or abruptly lobed tip.

Spores fusiform, aseptate, containing several large oil globules, about $37 \times 6 \mu$. Perithecia, $100 \times 30-33 \mu$. Total length, 130-138 μ .

On *Falagria dissecta* Er., Waverly, Mass., and Kittery Point, Maine.

This species is by no means uncommon on the lower surface of the abdomen, where its large projecting perithecia are readily seen at maturity. It also occurs on the upper surface of the thorax and head and more rarely on the legs and the upper surface of the abdomen. It is subject to little variation, figs. 17 and 18 representing almost the extremes of size; although forms sometimes occur slightly larger than that represented in fig. 17.

AMORPHOMYCES FLORIDANUS Thaxter. Plate V, fig. 30.

Proc. Am. Acad. Arts and Sci. Vol. XXVIII, p. 159.

Receptacle consisting of a basal cell, partly divided, from which arises on one side (corresponding to the ascigerous side of the perithecium) a somewhat indurated projection which extends upward nearly to the base of the perithecium. Perithecium very large, externally rounded and tapering considerably to the blunt apex, the basal cells, one of which is as large as the rest of the receptacle, forming a short stalk. Spores once-septate about $30 \times 5 \mu$. Perithecium, $150 \times 52 \mu$. Receptacle (including stalk-cells of perithecium) 62 μ long.

On *Bledius basalis* Lec., Florida.

Two specimens of this species were found on the abdomen of a single specimen of its host in the Le Conte collection of Staphylinidæ. As above stated it is almost certainly not an *Amorphomyces*; yet since the material is not sufficient to form the basis of a new generic diagnosis in the absence of a knowledge of the male sexual organs, it is here retained under the original name until further information can be obtained concerning it. It differs from *Amorphomyces* in having what appears to be a two-celled receptacle, the sub-basal cell very small and producing on one side a free projection (seen at the right in fig. 30), which is probably an antheridium; whether simple or compound can hardly be determined definitely; while from the other side rises the stalked perithecium, which is larger in proportion to the remainder of the plant than in any other known form. The spores are distinctly once-septate, as seen within the perithecium, and the large ascogenic cell appears to be solitary.

HELMINTHOPHANA Peyritsch. Plate VIII, fig. 10 (after Peyritsch).

Sitz. d. Wien. Acad. LXVIII, p. 250 (1873); *Arthrorynchus* Kolenati, Wiener Entomol. Monatschrift, I (1857), p. 66.

“Ein gestreckter gegliederter, mit spitzigen Fortsätzen versehener Zweig, scheinbar seitlich zwischen 1. und 2. Trägerzelle des Peritheciums inserirt; Perithecium mit einem Bauch- und Halstheil versehen, der Porus desselben wird von einem mehrlappigen Krönchen umgeben.” (Peyritsch l. c.)

This genus, of which I have seen no specimens, appears to be clearly separated from the allied *Stigmatomyces* through the presence of four instead of one vertical row of antheridial cells in its appendage. As far as can be determined from the figures, the appendage and the

stalk-cell of the perithecium arise from the sub-basal cell of the receptacle, as in so many other cases. The tip of the perithecium is peculiarly modified in the single species; but more exact information is needed on this point.

HELMINTHOPHANA NYCTERIBIÆ Peyritsch. Plate VIII, fig. 10 (after Peyritsch).

Sitz. d. Wien. Akad. LXVIII, p. 250; Sorokin Veg. Paras. Vol. II, p. 423, Plate XXXII, fig. 759: Winter Die Pilze Deutsch. II, p. 924, p. 920, fig. 3; Berlese, Malpighia, Vol. III, p. 58; Saccardo Sylloge Fung. Vol. VIII, p. 913; *Arthrorhynchus Westrumbii* Kolenati, Wiener Entom. Monatschr. (1857), p. 68; Diesing, Sitz. d. k. Akad. d. Wissensch. Wien, 1859, Vol. XXXVII, p. 752, Plate I, figs. 1-3; *Arthrorhynchus Diesingii* Kolenati, l. c. Diesing l. c. fig. 4.

Perithecium brownish yellow, its basal half slightly inflated, abruptly narrowed to the sub-cylindrical distal half, the apex composed of two series of small roundish cells, the upper forming four papillate prominences around the pore; the base consisting of four small cells terminating a long nearly cylindrical stalk-cell arising from the very small sub-basal cell of the receptacle. Antheridial appendage arising from the sub-basal cell of the receptacle, its lower half consisting of a single cylindrical stalk-cell, its upper of a single sterile cell above which three superposed cells form an axis from which arise the antheridia in four vertical rows. Receptacle of two cells, the basal roundish without any blackened foot. Total length to tip of perithecium, 390-750 μ .

On *Megistopoda Westwoodii* Kol., *Acrocholidia Montaguei* Kol., *Nycteribia Dufourii*, Middle Europe.

The two species described by Kolenati under the genus *Arthrorhynchus* are said by Peyritsch to be identical, although since they occur on generically distinct hosts it is not impossible that they may prove to be different. The original descriptions being based on supposed zoölogical characters, are quite unintelligible; while the figures of Diesing, apparently drawn from dry material, give no clue to any specific differences.

The hosts are wingless, dipterous parasites of bats, of which I have examined several American specimens, on which no *Laboulbeniæ* were to be found.

STIGMATOMYCES Karsten. Plate VIII, figs. 1-9; Plate I, figs. 1-26.

Chemismus der Pflanzenzelle, p. 78, Wien, 1869.

Receptacle consisting of two superposed cells, the upper giving rise to the single perithecium on one side and to the single appendage on the other. The perithecium various in form, stalked or sessile, sometimes appendiculate. Appendage consisting of an axis of superposed cells from which are developed on one side a single row of superposed antheridia separated from them by a septum or by a small cell. The antheridial cells flask-shaped, the venters more or less united, the necks projecting independently. Trichogyne simple, short, filamentous. Spores once septate.

This genus, although the three species that it contains are very diverse in form and appearance, is yet clearly characterized by the structure of its antheridial appendage; the latter being unlike that of any other genus with the exception of *Idiomycetes*, which it only remotely resembles. As will be seen by examining the figures on Plate I, the appendage is formed from the

terminal segment of the germinating spore, its basal cell only (figs. 6 and 10 *b*) being derived from the basal spore segment. The process by which the terminal segment becomes septate (fig. 3), and by which the antheridial cells are separated from the cells thus formed, is clearly shown by the series of figures (3-9); and, as will be noted, the antherozoids begin to make their escape some time before the female organ has developed. The origin and development of the procarpe has already been described in detail (p. 218), and further reference to it is unnecessary here.

The mature perithecium varies very considerably in the different species. Not only is its form variable, being rostrate in *S. entomophilus*, clavate in *S. virescens*, and conical in *S. Baeri*; but the relative position of its wall-cells is not the same in either case. *S. virescens* is remarkable from the fact that the position usually assumed by the basal wall-cells is taken by the basal cells of the perithecium, which extend up around the ascogenic cell and some distance above it (fig. 2). The perithecium of this form is moreover peculiar by reason of the appendages which are developed from its lip-cells. According to Karsten, two perithecia are sometimes formed in the same individual of *S. Baeri*; but I have not myself seen such an instance, and it is undoubtedly an abnormal occurrence. In all the species there are four cells in each of the series of wall-cells, although in *S. virescens*, for the reason just mentioned, there appear to be five. The ascogenic cells are four in number in *S. entomophilus* and *S. Baeri*; but in *S. virescens* there seems to be but one; certainly not more than two.

In exceptional instances, in which the female organ has not developed, the cells of the appendage, which would ordinarily have been converted into antheridial cells, may grow out into short secondary appendages, thus, as in other similar instances, greatly increasing the number of antheridial cells. This occurs very rarely in *S. Baeri*, but in *S. virescens* does not appear to be uncommon.

In *S. virescens* the stalk-cell of the perithecium is well developed, but in the other two it is the reverse, so that the latter is nearly or quite sessile. The hosts of the genus belong to the Diptera and Coleoptera.

STIGMATOMYCES BAERI Peyritsch. Plate VIII, fig. 9 (after Peyritsch); Plate I, figs. 1-26.

Sitz. d. Wien. Akad. Vol. LXVIII, p. 250 (1873); Berlese, Malpighia, Vol. III, p. 57; Winter Pilze Deutsch. Vol. II, p. 923, p. 920, fig. 2; Sorokin, Animal Parasites, Vol. II, p. 418, Plate XXXIII, fig. 788; *Laboulbenia Baeri* Knoch Assembl. d. Natural. d. Russie à St. Pétersb. p. 908 (1867); *Stigmatomyces muscæ* Karsten Chemismus d. Pflanzenzelle (1869), p. 78, fig. IX; Deutsche Flora (1880), p. 123; (1895) p. 119; Hedwigia, Vol. XXVII, p. 137, p. 138, fig. 3; Saccardo Sylloge, Vol. VIII, p. 913; *Laboulbenia muscæ* Peyritsch l. c. Vol. LXIV, p. 444, Plate I; *Laboulbenia Pitrazana* Sorokin, Mykologische Versuche, Charkow, 1871, p. 39, Plate IV, figs. 1-9; Bot. Zeitung (1872), p. 339.

Perithecium brownish yellow, its lower half sub-cylindrical stout, somewhat abruptly distinguished from the sub-conical terminal portion; the tip slightly pointed and incurved, the cell rows spirally twisted. The appendage borne on a distinct free basal cell, curved, consisting of five or six obliquely superposed series of cells, the outer cell (antheridium) of each series projecting free from the one or two cells below its base, which may be partly united with the venters of adjacent antheridia. Receptacle consisting of a sub-cylindrical basal and sub-basal cell; the foot rather small and blackened. Total length to tip of perithecium, 230-400 μ (Peyritsch). Perithecium, 140-180 \times 40-58 μ . Appendage about 85 μ . Spores, 27-30 \times 4 μ .

On *Musca domestica* L., Europe.

I am indebted to Miss Helen Bondy, of Vienna, for material of this interesting form, which I found sufficiently abundant on house flies, of which she was kind enough to send me a large collection. The parasites were attached to all parts of the host, but as a rule were more commonly found on the back of the head and thorax and near the base of the anterior pair of legs and the adjacent portions of the body. Although there seems to be a tendency in the case of female flies to bear the parasite on the upper, and of males to bear it on the lower side, as a result of transference during *coitus*, I have found this condition by no means invariable as stated by Peyritsch. The original account given by Karsten appears to be distinctly more correct than that of Peyritsch; since he not only saw and figured the trichogyne with antherozoids attached, but noted the twisting of the wall-cells of the perithecium, which seems to have been overlooked by the latter observer.

The figure of a mature specimen (Plate VIII, fig. 9) was reproduced from Peyritsch before the material mentioned was obtained; but is sufficiently good for purposes of identification. I have searched for the species in several localities in this country without success; but even if it is not indigenous, it is very improbable that it does not occur here in view of the habits of its host, large numbers of which are being constantly imported from Europe on vessels.

I have not seen the original paper of Knoch in which the species was first described; yet if the title given by Peyritsch is correct, "*Laboulbenia Baeri* Knoch, einer neuer Pilz auf Fliegen," one cannot agree with the conclusions of Karsten (*Hedwigia* l. c.) by which the name *Stigmatomyces Muscæ* Karsten is retained.

STIGMATOMYCES ENTOMOPHILUS Thaxter. Plate VIII, figs. 5-8.

Proc. Am. Acad. Arts and Sci. Vol. XXIV, p. 8; *Appendicularia entomophila* Peck, 38th Report (1885), p. 95, Plate III, figs. 1-4; Berlese and Voglino in Saccardo, *Sylloge Fungorum, Additamenta ad Vols. I-IV*, p. 354; *Appendiculina entomophila* Berlese, *Malpighia*, Vol. III, p. 59, Plate II, figs. 1-5; Saccardo *Sylloge*, Vol. VIII, p. 914. See also Gerke: *Wiener Entomol. Zeitung*, V, p. 168; Taf. II, fig. 14 (1886).

Perithecium consisting of an ovoid, pale amber-brown base, abruptly narrowed above to form the greatly elongated sub-cylindrical, beak-like, nearly hyaline distal portion. Receptacle tinged with yellowish, long and slender, consisting of a basal and greatly elongated sub-basal cell, followed by two cells, a posterior longer and narrower, which bears the appendage, and an anterior (stalk-cell), separated from the perithecium by four small cells. Appendage small, consisting of a more or less rounded basal cell, bearing the usual series of cells, the venters of the successive antheridial cells more or less completely united, the necks papillate, not very prominent. Spores, $40 \times 3.7 \mu$. Perithecium, $275-300 \mu$ long, its base about $90 \times 60 \mu$, its terminal beak about $195 \times 18 \mu$. Receptacle, $300-325 \times 30 \mu$. Appendage about 55μ long.

On *Drosophila nigricornis* Loew., Nyack, New York (J. L. Zabriskie). On *D. funebris* F., Europe (G. Gerke).

I am greatly indebted to its discoverer for several preparations of this curious form, which was originally collected by him on small flies found in a cellar during the month of March. The species is chiefly remarkable for the great elongation of the sub-basal wall-cells of the perithecium, which form almost the whole of its slender, beak-like, terminal portion. Professor

Giard has kindly called to my notice a reference by Gerke in the Wiener Entomologische Zeitung to a parasite on *Drosophila funebris*, found by him in June, 1877. Though his figure is somewhat insufficient, it is more than probable that the plant which he describes is identical with the present species. The figures are evidently drawn from dried and shrivelled specimens, and no appendage is visible, although otherwise they correspond essentially with the American form.

Professor Peck, in his original description, represents the spores as divided by a median septum, but in the material examined they appear to be of the usual type as represented in fig. 8. The host occurs in cellars and similar situations, where it is commonly found hovering over decaying fruit, etc.

STIGMATOMYCES VIRESCENS Thaxter. Plate VIII, figs. 1-4.

Proc. Am. Acad. Arts and Sci. Vol. XIX, p. 106; *Hesperomyces virescens* Thaxter, l. c. Vol. XXIV, p. 264.

Color yellowish green. Perithecium large, clavate or sub-clavate, constricted more or less prominently at the transverse septa between its successive wall-cells, straight on the inner side, rounded externally; the distal series of wall-cells forming the tip, the small terminal cells thus formed producing from four to eight appendages; the outer short or obsolete, the inner consisting of two antero-posterior wedge-shaped prominences, between which lies the pore; and two much longer, divergent, tapering, sometimes septate, lateral appendages. The ascogenic cell perhaps solitary (?), becoming pushed down between the proper basal cells of the perithecium, which thus appears to have five sets of wall-cells. Appendage abruptly constricted at its base, the antheridial cells, usually five in number, distinct, except at the base. Receptacle sharply pointed below, small, sub-triangular, consisting of a basal cell and two smaller terminal cells, the posterior smaller bearing the appendage, the anterior the stalk cell of the perithecium, which equals or exceeds the main body of the receptacle in size. Spores, $65 \times 6 \mu$. Perithecia, $190-275 \times 66 \mu$; its longer terminal appendages, $40-45 \mu$. Receptacle, $75 \times 30 \mu$. Antheridial appendage, $75 \times 13 \mu$. Total length to tip of perithecium, $300-400 \mu$.

On *Chilocorus bivulnerus* Muls., California.

I am greatly indebted to Mr. D. W. Coquillett for two specimens of the above host taken at Los Angeles, which bear the parasite on the legs and on the lower surface of the abdomen; where, owing to its large size and contrasting color, it is readily seen with the naked eye. A further knowledge of the family shows that the characters relied upon for distinguishing the genus *Hesperomyces* have merely a specific significance; and that while the number of wall-cells of the perithecium appears to be greater than in the other species of *Stigmatomyces*, they are in reality the same, as indicated in the above description. The receptacle, moreover, may without difficulty be reduced to the same type, although from the obliquity of the septa and somewhat different relative position of its cells, the insertion of the appendage might at first sight seem abnormal. The spores sometimes present a peculiar appearance, through a local inflation of their smaller segment.

IDIOMYCES Thaxter. Plate IX, figs. 16–21.

Proc. Am. Acad. Arts and Sci. Vol. XXVIII, p. 162.

Receptacle consisting of two superposed cells, followed by two cells, an anterior and a posterior, — the posterior cell followed by a vertical series of superposed cells bearing externally fertile and sterile appendages in three vertical rows; the anterior cell producing one or more stalked perithecia and numerous fertile appendages arising from small cells separated from it distally. Perithecia symmetrical with four ascogenic cells. Fertile appendages consisting of a single series of superposed cells, bearing on one side three vertical rows of flask-shaped antheridial cells. Spores once-septate.

This genus is nearly related to *Stigmatomyces*, through the structure of its peculiar appendages, which are very similar, except for the presence of three instead of one row of antheridial cells. Viewed laterally (fig. 18), it is not possible to determine the number of rows; but a face view, such as is shown in fig. 19, shows the slender necks of the three antheridial cells projecting side by side at regular intervals. The sterile appendages (fig. 20) consist also of a series of superposed cells, each producing a single sterile lateral branch.

The receptacle is somewhat complicated in structure, consisting of four cells arranged as above described, the peculiarly differentiated posterior series of superposed cells, which bear the appendages externally, recalling, in a way, the primary appendage of *Ceratomyces*. The cell which produces the perithecia becomes distally divided, usually on one side only, the cells thus formed producing the second set of appendages, which, in well developed specimens, may be very numerous and extend almost completely around the base of the stalk-cell of the perithecium on both sides. Fresh material for a more minute examination of this genus is greatly to be desired, since the specimens of the single species which constitute the types are in very poor condition, with the exception of the one from which fig. 17 was derived.

IDIOMYCES PEYRITSCHII Thaxter. Plate IX, figs. 16–21.

Proc. Am. Acad. Arts and Sci. Vol. XXVIII, p. 162.

More or less tinged with yellowish or amber brown. Receptacle consisting of two superposed basal cells, surmounted by two cells; the outer, having a very thick external wall which forms a distinct prominence distally, is succeeded by a row of about five or six superposed, more or less flattened cells, extending beyond the base of the stalk-cell of the perithecium, which bear externally three vertical series of closely-set appendages: the inner is succeeded by a single rounded cell followed by several small cells, which give rise to a series of similar appendages variable in number. Appendages mostly fertile, borne on one or two squarish basal cells, terminated by a simple or once branched short sterile filament. Perithecia short, thick, sub-conical, the apex sub-truncate, the base inflated, borne on a long stalk made up of a single basal and two sub-basal cells, the outer directly in contact with the perithecium, the inner separated from it by two small cells. Spores, $60 \times 4 \mu$. Perithecia, $110-130 \times 60-70 \mu$. Appendages longer, 80μ . Receptacle, $130-165 \times 70-95 \mu$. Stalk of perithecium, longest, 200μ .

On *Deleaster dichrous* Grav., Germany.

The types of this species were found on the upper surface of the abdomen of its curious host, among specimens of the latter contained in the Museum collection at Cambridge. The dozen types obtained show a considerable variation in the number and position of the appendages at the base of the stalk-cells of the perithecium. The latter appear to arise always from the same cell, whether the individual produces one perithecium or more than one. In a single instance three perithecia are developed, while a majority appear to have two. The few specimens accessible of the only American *Deleaster* were examined carefully, in the hopes of finding a similar parasite, but without success.

CORETHROMYCES Thaxter. Plate IX, figs. 1-6.

Proc. Am. Acad. Arts and Sci. Vol. XXVII, p. 36, and XXVIII, p. 180.

Receptacle consisting of several superposed cells, the sub-basal cell and rarely also the cell above it producing a stalked perithecium, the terminal cells giving rise to several branched appendages. Antheridial cells superposed to form an obliquely septate branchlet with projecting necks. Perithecium symmetrical or nearly so, the stalk-cell well developed; its cell-rows of four cells each. Spores once-septate. Trichogyne filamentous, simple or branched.

The material on which the original description of this genus is based was so insufficient that it has been necessary essentially to modify the present diagnosis in the light of more abundant data subsequently obtained. It approaches *Rhadinomyces* more closely than any other genus, especially in the character of its antheridia, and may eventually have to be united with it. In all three species, however, a cell is present above the sub-basal cell of the receptacle, which is either sterile or produces a second perithecium, while in *Rhadinomyces* the secondary perithecia, which are very commonly developed, arise invariably from the sub-basal cell of the receptacle. There are other differences in general habit, character of the appendages, and details of structure in the antheridial branchlets, which, though of less importance, all tend to make it seem advisable to keep these genera distinct until further data concerning them can be obtained.

In development the spore first divides into five superposed cells. The terminal one by successive proliferation from one side, produces a tuft of terminal branches and branchlets, which are often broken or obsolete in older individuals. The sub-basal cell produces a single perithecium, which first appears as a triangular cell cut off from its anterior upper portion, as in *Laboulbenia*. The cell above this either remains unchanged or produces a second perithecium, while the sub-terminal cell gives rise to the main appendages. The antheridia arise as branchlets from the main appendages, the terminal cells of which are sterile. The trichogyne is well developed, slender, septate, and more or less branched.

The three species are found on beetles belonging to the Staphylinidæ, and inhabiting very wet situations, especially along the margins of streams or ponds.

CORETHROMYCES CRYPTOBII Thaxter. Plate VII, figs. 1-2.

Proc. Am. Acad. Arts and Sci. Vol. XXVII, p. 36, and XXVIII, p. 181.

Perithecium usually very long and slender, becoming uniformly suffused with brown; straight, slightly inflated toward its base, tapering very gradually to its blunt symmetrical apex;

its stalk-cell hyaline, blackened at its base, two or three times as long as broad, its basal cells not abruptly distinguished, and concolorous with it; the inner as long as the stalk-cell. Receptacle short, narrowed below, the basal cell small, hyaline or brown and translucent, the rest black, opaque. Terminal appendages short, usually broken or obsolete, the main (lateral) appendages primarily two in number: an upper simple, a lower furcate near its base, each consisting of a main more or less obliquely septate axis, from which numerous obliquely septate more or less appressed branches are produced externally, which may themselves produce simple branchlets; the branches externally opaque. Spores, $40 \times 4 \mu$. Perithecia, including basal cells, 415×50 – $130 \times 33 \mu$. Average, 290μ long; the stalk-cell, 37 – 95μ long. Appendages, 130 – 536μ long. Total length to tip of perithecium, 600 – 200μ .

On *Cryptobium pallipes* Grav., and *C. bicolor* Grav., Virginia, Pennsylvania, Kansas. *

The type of this fine species was found on the leg of a specimen of *C. pallipes* sent me from Virginia by Mr. Pergande, and a small number of examples was subsequently found on a specimen of *C. bicolor* in the Museum collection. More recently a large number of both these hosts, sent me from Kansas by Mr. M. A. Barber, have yielded abundant material, and it is much to be regretted that the figures given on Plate IX. should not have been drawn from these perfect and well developed specimens. The species varies very greatly in size, as may be inferred from the above measurements, as well as in the relative length of its different parts. In perfectly developed specimens the appendages often slightly exceed the tip of the perithecium. There is a good deal of variation in the number and length of the branchlets, more than one commonly arising from each cell of the main axis, which, though straight and rigid, appear to be formed as a result of successive sympodial branching. Specimens occurring on the abdomen of the host are commonly far larger than those which are attached to the legs. In general appearance the species recalls in some respects the remarkable East Indian *Laboulbenia palmella* (Plate XVIII, fig. 11), but the resemblance is wholly superficial. The hosts above mentioned are large and conspicuous Staphylinid beetles, common under stones and in wet rubbish along the margins of streams and ponds.

CORETHROMYCES JACOBINUS Thaxter. Plate IX, figs. 3–5.

Proc. Am. Acad. Arts and Sci. Vol. XXVIII, p. 181.

Perithecium hyaline, becoming faintly brownish, rather short, somewhat inflated, tapering to a blunt apex. Receptacle short, the basal cell small, hyaline; partly, sometimes wholly, black and opaque. Appendages arising in a fan-like tuft, the two or three main axes usually short, formed by sympodial branching; the branchlets once or twice branched, much longer, the outer becoming brown, the inner mostly hyaline. Perithecia, 65 – $75 \times 22 \mu$. Appendages about 160 – 200μ long. Total length to tip of perithecium about 150μ .

On *Lathrobium jacobinum* Lec., California; on *L. collare* Er., Kittery Point, Maine; on *Lathrobium* sp., Arlington, Mass.

This small species varies very greatly in luxuriance; figures 3 and 4 representing more or less extreme cases, between which every degree of development may be seen. In a few instances two perithecia are formed, one above the other, as already described. The form, though so

widely distributed, is apparently a rare one, and abundant material is needed for its further study. The hosts on which it occurs were taken under stones and in moss at the borders of ponds.

CORETHROMYCES SETIGERUS Thaxter. Plate IX, fig. 6.

Proc. Am. Acad. Arts and Sci. Vol. XXVIII, p. 181.

Perithecium becoming tinged with brown, slightly inflated and tapering to the blunt apex; stalk-cell hyaline, long. Appendages arising from the distal and sub-distal cells of the receptacle, consisting of two or three rounded basal cells, which bear numerous long, straight, cylindrical, septate, deep brown branches, some of them once branched, the whole curved slightly outward and forming a crest-like structure. Basal cell of receptacle hyaline, the rest, including the two appendage-bearing cells, strongly blackened externally. Perithecia, $110 \times 35 \mu$. Spores (measured in perithecium), $30 \times 4 \mu$. Total length of appendages, 200μ or more. Two basal cells of receptacle, $35 \times 15 \mu$. Total length from base to tip of perithecium, $200-220 \mu$.

On thorax of *Lathrobium nitidulum* Lec., Massachusetts; on *L. tenue* Lec., Michigan.

This species is closely allied to the preceding, yet seems sufficiently well marked to keep distinct. Its appendages are quite characteristic, recalling those of *Laboulbenia cristata*. The main axes seem almost obsolete, being reduced to several rounded cells, which form a group, from which arise the long, rigid, brown branches. The stalk-cells and lower basal cells of the perithecium are much larger than in *C. jacobinus*, as is the perithecium itself. The material examined was all obtained from specimens in the Museum at Cambridge, and is not in very good condition.

RHADINOMYCES Thaxter. Plate IX, figs. 7-15.

Proc. Am. Acad. Arts and Sci. Vol. XXVIII, p. 179.

Receptacle consisting of two superposed cells, from the upper of which arise one to several stalked perithecia and a main appendage; the appendage consisting of three superposed cells, the upper bearing terminally a series of simple sterile branches, the two lower producing from their distal ends short antheridial branches or long sterile branches or both. Antheridial cells flask-shaped, superposed in short series. Perithecia borne on a single stalk cell followed by four basal cells; its wall-cells four in each series. Spores once-septate. Trichogyne filamentous, simple or branched. Ascogenic cells, four.

In some instances the sub-basal cell of the receptacle may produce one or more antheridial branchlets directly, in addition to those on the main appendage. The antheridial cells are sometimes single, more often superposed in threes, the upper one being free and terminal. A few specimens have been observed in which the antheridial branchlets, instead of being borne directly from the primary appendage, as in fig. 12, arise from some of its ordinarily sterile branches.

The ascogenic cells are readily made out in the paler species, and at maturity four may be usually distinguished; but this number does not seem to be constant even in the same species. In a few instances a peculiar spine, present also in other genera, has been observed near

the base of the primary sterile branch (fig. 22) in *R. cristatus*; but its significance is undetermined.

As has been previously mentioned, it may eventually prove necessary to unite this genus with *Corethromyces*.

RHADINOMYCES PALLIDUS. Plate IX, figs. 7-9.

Proc. Am. Acad. Arts and Sci. Vol. XXVIII, p. 180.

Hyaline or slightly yellowish. Perithecium becoming pale amber brown, except the tip, which is colorless; more or less inflated, conical above, the apex blunt symmetrical, the stalk-cell about as long as the receptacle. Receptacle small, the basal cell somewhat larger than the sub-basal. Appendage of three nearly equal cells, the distal bearing terminally from one to three sterile, simple, tapering flexuous branches; the other two producing distally groups of antheridial branchlets arising from small cells cut off from their upper inner angles. Spores, $45 \times 3.7 \mu$. Perithecia, $86 \times 33 \mu$. Primary appendage about 60μ , its longer branches $225-375 \mu$. Total length to tip of perithecium, average 200μ .

On *Lathrobium punctulatum* Lec., and *L. angulare* Lec., vicinity of Cambridge, Mass., and Kittery Point, Maine.

Var. a. Plate IX, fig. 10-11. Larger than the type, the perithecia proportionately narrower, becoming evenly suffused with amber yellow. Appendage often relatively shorter with numerous sterile branches arising from all its cells, often crowded, and usually producing short antheridial branchlets. Perithecia, larger, $165 \times 45 \mu$. Spores, $44 \times 4 \mu$. Appendage, $37-150 \mu$; its longest branches about 300μ . Total length to tip of perithecium (larger), 425μ .

Occurring with the type on *L. punctulatum* Lec.; on *L. fulvipenne* Grav., Germany.

As a matter of convenience I have separated from the type, which is on the whole moderately constant, a series of larger forms often occurring with it and approaching *L. cristatus* in some respects. While in the type the size is small, the perithecia pale amber brown with hyaline tips at maturity, the branches of the appendage few in number, with the antheridia borne in the typical fashion directly from the main appendage; in the variety very considerable differences in size and general habit are noticeable. While in the type two perithecia are unusual, in the variety there are sometimes five, uniformly tinged with amber yellow; the appendage is apt to be much more copiously branched, and though this is not always the case, it is often decidedly shortened, with a corresponding increase in the luxuriance of its branches. In the European specimens the appendage is more normal in form and much like that of *R. cristatus*, which in the end may prove a mere variety. It is also distinctly larger even than the ordinary American forms of the variety, but cannot be separated specifically.

RHADINOMYCES CRISTATUS Thaxter. Plate IX, figs. 12-15, 22-23.

Proc. Am. Acad. Arts and Sci. Vol. XXVIII, p. 180.

Perithecia one to four, hyaline, becoming yellowish or pale brownish, the stalk-cell as long as or considerably longer than the perithecium proper. Appendage large, the terminal cell bearing distally a series of from two to six (usually four) long, stiff, cylindrical, septate, dark red brown

simple branches, arising side by side antero-posteriorly; the middle cell usually bears a single similar sterile branch arising from a small cell cut off from its upper inner angle, and also sometimes producing an antheridial branchlet; the basal cell has two cells similarly cut off from its distal end on either side, each producing antheridial branchlets. Spores, $50 \times 4 \mu$. Perithecia, $125-140 \times 30 \mu$; the stalk-cell, $75-170 \mu$. Main appendage, $110-185 \times 18 \mu$; its longest branches, 750μ .

On *Lathrobium nitidulum* Lec., and *L. punctulatum* Lec., Cambridge, Mass., and Kittery Point, Maine.

This striking form does not appear to vary to any great extent even on the two hosts above mentioned, and well developed specimens correspond closely to the type figured on Plate IX (fig. 12). The long, brown, rigid branches of its appendages are perhaps the most striking apparent difference which distinguishes it from *R. pallidus*; but although with only the type of *R. pallidus* before him (figs. 7-8), one would hardly hesitate in separating the two species, the European material and some of the varietal forms of this species render it not altogether certain that the present form is distinct. The fact, however, that *R. pallidus* occurs on the same host (*L. punctulatum*) in the same position and in its typical form, and that no tendency to variation toward *R. pallidus* is visible in the abundant material of *R. cristatus*, derived from several specimens of this host on which it was found at Kittery, indicates that at least these differences are not variations due to the position of growth or the character of the host.

The hosts affected were collected in considerable numbers about wet bogs or beside ponds; but the species seem very rare.

RHIZOMYCES nov. gen. Plates III-IV.

Receptacle consisting of two cells, the lower with rhizoid-like outgrowths from its base which penetrate the body cavity of the host. Perithecia solitary, borne on a stalk-cell arising from the sub-basal cell. Antheridial appendages consisting of numerous superposed cells all of which, except the lowest, produce externally antheridial branches, their basal cells bearing simple antheridia of the usual flask-shaped type.

This genus is clearly distinguished from all others by the structure of its strikingly peculiar appendage. The antheridia, however, are exactly like those of Laboulbenia, although the appendage in other respects differs fundamentally from that which is found in the genus just mentioned. It seems only remotely allied to any of the known genera, and is unique in that it produces from its basal cell well developed, semi-filamentous branching rhizoids (Plate IV, fig. 3), which penetrate the body cavity of the host, the softer chitinous integument of which it inhabits. The main axis of the appendage appears to result from successive sympodial branching, each cell representing the base of a sympodial branch, on which the corresponding antheridial branch was at first terminal. From the fact that the types are all mature individuals, the early stages of development were not seen; yet it seems improbable that they present any great peculiarities, unless perhaps as regards the trichogyne. In the type species the position of the ascogenic cells, of which there are two lying side by side in the mature perithecium, is unusual, the long axis being turned at a considerable angle to that of the perithecium, instead of coincid-

ing with it, as is usually the case; so that all the younger asci are seen pointing outward and downward (Plate III, fig. 3). The spores are unusually minute in proportion to the size of the perithecium, and it is possible that the asci may be eight-spored. Seen within the perithecium, however, they seem to be four-spored.

RHIZOMYCES CTENOPHORUS nov. sp. Plate III, fig. 3; Plate IV, figs. 1-4.

Perithecium, including its basal cells, dark amber brown, asymmetrical, the lower half somewhat inflated, the rather truncate tip not distinguished from the tapering, neck-like, slightly bent upper half; the sub-terminal wall-cells marked by fine transverse striations; the lower half not distinguished from the basal cells, which are themselves abruptly distinguished from the long, slender, cylindrical stalk-cell. The basal cell of the receptacle rounded below, about half as large as the sub-basal, the rhizoids rather copiously and irregularly branched or lobed, colorless. Appendage shorter than the stalk-cell of the perithecium; the axis simple or exceptionally furcate near the base, consisting usually of about thirteen superposed cells; the basal cell small, blackened and somewhat constricted; the rest producing antheridial branches always on the same side, forming a unilateral series; the branches in turn several times more or less sympodially branched; the branchlets distally somewhat indurated and suffused with blackish brown, the whole forming a comb-like tuft; the ultimate branchlets curved outward and downward. Antheridia long, flask-shaped, sessile, borne rather irregularly, one to four together, from the upper surface of the basal cell of the antheridial branch; sometimes also from the sub-basal cell. Spores, $25 \times 3 \mu$. Perithecium, including basal cells, $180-200 \times 62-70 \mu$; smallest, $120 \times 35 \mu$; the stalk-cell, $275-620 \times 35 \mu$; average, 550μ long. Appendage, longer, $325-340 \mu$; greatest diameter of axis, 17μ ; antheridial branches, longer, $45-50 \mu$. Receptacle, $60 \times 45 \mu$. Rhizoids, longer, $86 \times 13 \mu$. Total length to tip of perithecium, longer, $800-880$.

On *Diopsis thoracica* Westw., Coffee Hill, Liberia (O. F. Cooke) and Zanzibar.

This fine species was found growing in a tuft on the soft chitin of the lower surface of the abdomen of its peculiar host, and although it is difficult to detach the plant without breaking its rhizoids, a few specimens were obtained which show them little injured, and with portions of the host's integument still adherent about the constriction which separates them from the basal cell of the receptacle. The appendage is among the most striking in the group, and from the flat, uniseriate arrangement of the sterile branchlets from the antheridial branches, bears a certain resemblance to a large comb or series of small combs. The branches which arise at or near the extremity of the appendage are usually wholly sterile, and in the fertile ones there is little regularity in the number of antheridia. The striation of the sub-terminal wall-cells of the perithecium seems to be a constant and peculiar character; but is not so conspicuous that it might not be readily overlooked.

LABOULBENIA Montagne and Robin (1853). Plates I-IV, XIII-XXII.

Receptacle consisting typically of seven cells, exclusive of three small cells which form the base of the perithecium; the two lower (cells I and II) superposed and forming the receptacle proper; the cells above them arranged in an anterior and posterior series, the latter consisting

of two cells, a lower (cell II) and an upper (cell IV), the inner upper portion of which is separated as a third cell (cell V, which is in reality made up of two cells placed side by side), the former consisting of a lower (cell VI) and an upper (cell VII) obliquely superposed. Appendages arising from a blackened insertion cell above cells IV and V (exceptionally from a variable number of subdivisions of these cells, in which case the black insertion cell is wanting). Perithecium solitary, compressed, asymmetrical or nearly symmetrical, rarely appendiculate, sessile or stalked, having four wall-cells in each longitudinal row. Appendages sometimes numerous, but typically consisting of two basal cells, from the outer of which arises one, from the inner two branches or series of branches, the inner fertile bearing the flask-shaped antheridia, singly or more or less irregularly grouped. Ascogenic cells two, lateral. Asci four-spored. Spores once septate. Trichogyne filamentous, simple or branched.

Owing to the occurrence of several exceptional modifications in the structure of certain members of this genus, it is very difficult to characterize it briefly and concisely; and owing to the fact that it contains nearly half of all the members of the family, its variations are, as might be expected, very considerable. The more striking departures from what may be considered the type form, are illustrated by the following species: *L. Gyrinidarum*, *L. Guerinii*, *L. Orectogyri*, *L. Oberthuri*, *L. variabilis*, *L. brachiata*, *L. fasciculata*, and to a less extent by *L. proliferans* (Plates XXI and XXII), in all of which the usual black insertion cell is absent or modified, while cells IV and V have undergone division above into a series of cells differently arranged in different cases, all of which may give rise to appendages. A further abnormal septation of these two cells of a somewhat different character is seen in *L. Clivinæ* (Plate XXI, figs. 16-17), a species otherwise peculiar for the coalescence of its appendages at the base. Typically the black insertion cell bears above it two cells, an outer forming the base of a single simple or branched sterile appendage; the inner giving rise on either side to a branch which is fertile and may be variously divided. The complications of this simple type are, however, numerous and often very striking, resulting either from the sub-division of one or of both of these basal cells, and the production from them of more numerous branches; or from a combination of both these modifications. Such variations are well illustrated by species like *L. Brachini*, *L. luxurians*, *L. minima*, *L. zanzibarina* or *L. Galeritæ*.

A second departure from the type form is illustrated by such species as *L. Kunkeli*, *L. longicollis*, *L. Galeritæ* and their allies (Plates XVIII and XIX), in which the lower cells in each of the four series of wall-cells of the perithecium become greatly elongated, forming a well defined stalk on which the latter appears to be borne.

The perithecium is also subject to considerable variation in form, especially as regards the modifications of its lip-cells. In two cases the latter are appendiculate (*L. Gyrinidarum* and *L. cornuta*); while in others they are curiously expanded (*L. umbonata*, *L. texana*, etc.) or irregular. The four rows of wall-cells may sometimes show a distinct spiral twist, as in *L. arcuata*, *L. decipiens* (Plates XVIII and XX) and a few other forms, and are composed of four cells each; although, except in younger specimens, the usual blackening below the pore obscures the upper septa.

The trichogyne, although it is sometimes merely a simple, sparingly septate filament, is more commonly, often very copiously branched, the receptive tips being either straight (Plate II, fig. 3), or in many instances spirally twisted (Plate XXI, fig. 15). The antheridia are generally very

uniform, but vary greatly in their numbers, being sometimes solitary or nearly so, as in *Laboulbenia Pachytelis*, or produced in great numbers, as in *L. Brachini* and several others. Their arrangement on the antheridial branchlets may be characteristic; for while as a rule they are apt to be solitary, in species like *L. variabilis* (Plate XXI, fig. 3), or *L. proliferans* (Plate XVII, fig. 23), they are more or less definitely grouped.

The homologies of the "receptacle" are evidently such as have been previously described (p. 206), the cells above cell II (Plate II, fig. 5) representing the union of the stalk-cells of the perithecium (cells VI and VII; *h* and *p* of the figure), with the base of the appendage (cells III to V), the latter (cell V) being, as may be seen when they have been separated by potash, in reality a pair of cells placed side by side and appearing like one. The bodies spoken of as the "appendages" in this genus are therefore morphologically only the branches of a main appendage.

With the few exceptions above mentioned, the type structure of the individuals which compose the genus is remarkably constant and very clearly defined; so that little difficulty will be experienced in distinguishing it from all others. Its immediate connections with other genera are not, however, clear, and its nearest ally is difficult to designate.

The aquatic forms already enumerated might perhaps be separated in a genus by themselves, were it not for the fact that their chief peculiarity, namely, the origin of their appendages, is almost exactly paralleled by *L. variabilis*, which can by no possibility be excluded from *Laboulbenia*. Unless other more important points of difference should appear, it is impossible thus to separate them. It may, however, be remarked in passing that *L. Gyrinidarum* is one of the very few species in which the character of the antheridia has not yet been satisfactorily made out, although the trichogyne is highly developed.

In the following descriptions the black cell from which the appendages arise is spoken of as the "insertion-cell," the cells of the receptacle being numbered (I to VI), as in fig. 5, Plate II, and the side bearing the perithecium is considered anterior. The species are sometimes cosmopolitan, and are very numerous and varied, inhabiting a great variety of hosts, including Coleoptera, Diptera, Neuroptera and the Acarini. Many of the forms of what I have called the "*flagellata*" type are very variable, and given species may inhabit hosts of many species and even genera. Specific determinations are thus often difficult, and in the group of species represented by *L. flagellata*, *L. anceps*, *L. elongata*, *L. Peterostichi*, *L. polyphaga*, there is much uncertainty in regard to the identities of many of the varieties. The synonymy in these cases is also confused, and some names may have to be discarded.

LABOULBENIA ROUGETHI Mont. et Robin.

Robin, Hist. Nat. d. Veg. Par. p. 622, Plate X, fig. 2; Montagne, Sylloge Cryptog. p. 250; Peyritsch Sitz. d. Wien. Acad. Vol. LXVIII, p. 247; Sorokin, Veg. Par. of Man and Anim. as a Cause of Contagious Diseases, Vol. II, p. 412, Plate XXXIII, fig. 781; Winter, Die Pilze Deutsch. II, p. 921; Berlese Malpighia, Vol. III, p. 54; also in Saccardo, Sylloge Fung. Vol. VIII, p. 911; Thaxter, Proc. Am. Acad. Arts and Sci. Vol. XXIV, p. 12. See also Rouget, Production Paras., etc. in Ann. d. l. Soc. Entomol. d. France, 1850, T. VIII, p. 21, Plate I, figs. 1-7.

"Dark yellow-brown; Paraphyses inserted on a broad base, irregularly dichotomous, about as long as the perithecium, yellow; stalk much shorter than the perithecium."

On *Brachinus crepitans* L., *B. scolopeta* F., *B. explodens* Duft., Europe.

The above description is quoted from Peyritsch (l. c.), although it is quite useless for purposes of identification. The figures given by Robin appear at first sight to be good, and to furnish a means of identifying the species; but some of them are almost certainly incorrect in their anatomical details, and it is doubtful whether any of them are to be depended upon, either as exact reproductions of the originals or as exhibiting the essential characters of the species. I have examined specimens of a Laboulbenia from *B. explodens*, taken in Germany, but in all cases they correspond to the rather well marked type which I have called *L. europæa* (Plate XVI, fig. 15), a form which is known to occur on several other hosts.

In a previous paper (l. c.) I have doubtfully referred to this species a form found growing densely crowded on the legs of *Platynus cincticollis* in this country; but a comparison of almost unlimited material of the various forms which I have placed together under *L. elongata* makes it clear that our form cannot be considered to be the species of Robin, unless, perhaps, the whole "*flagellata*" series should be united under his name. Whether *L. Rougetii*, which is unfortunately the type of the genus, is really distinct from either *L. elongata*, *L. flagellata*, *L. anceps*, or *L. europæa* must remain uncertain until sufficient material of the European forms on *Brachinus* has been examined to make clear what is really intended by Robin's name. It should be mentioned, however, that I have never seen a specimen of *L. flagellata* on any of the very numerous specimens of American *Brachinus* examined, even from situations where species of *Platynus* infested by *L. elongata* were common. The forms of *L. Brachini* (Plate XX, fig. 2), which at first sight seem identical with some of the varieties of *L. elongata*, cannot be confused, on careful comparison, either with this species or with *L. Europæa*.

A few old specimens of *L. europæa* in my possession, from European material of *Brachinus*, in which the appendages have been broken and have produced a few abnormal branches at the base, bear, it must be admitted, a distinct resemblance to the dark brown figure of Robin's Plate X.

LABOULBENIA EUROPÆA Thaxter. Plate XVI, figs. 15-17.

Amber-brown. Perithecium darker amber-colored, rather narrow, but sometimes inflated, its tip nearly straight, broad, black except the edges of the coarse lips, which are turned slightly outward, an olive shade extending below the blackened portion. Outer appendage hyaline, suffused below with olive-brown, deeply colored externally near the base, simple or more commonly consisting of a basal and a sub-basal cell which bears two long slender tapering branches; more rarely the basal cell bears two branches directly, the inner simple, the outer bearing two branches from its basal cell. Inner appendage consisting of a basal cell which may bear two branches directly, or more commonly is followed by a sub-basal cell bearing a long, simple, sterile branch and a shorter fertile branch, producing several antheridia and one or two sterile divisions, which sometimes become elongate. Receptacle normal, a very slight olive suffusion on the external surface of cell IV. Spores, $55-59 \times 4-4.5 \mu$. Perithecia, $130-140 \times 55 \mu$. Appendages (longest), 250μ . Total length to tip of perithecium, $250-300 \mu$.

On *Chlænius aneocephalus* Dej., *C. chrysocephalus* Rossi, *Callistus lunatus* Fabr., *Aptinus mutilatus* Fabr., *Brachinus explodens* Duft., Europe.

This species, although occurring on such a variety of hosts, is very constant in its essential characters, and appears to be undoubtedly distinct from *L. flagellata* and its near allies. Its general color, the shape of its perithecium, the olive coloration at the base of its outer appendage, and the blackened external branch of the latter, serve to distinguish it readily. It is allied to *L. flagellata* and *L. Pterostichi*, and as already mentioned, may eventually prove to be the form intended by Robin as the type of his *L. Rougetii*, although the data available for distinguishing this species would hardly lead one to unite the two. The specimens examined are from Greece and Central Europe.

LABOULBENIA ELONGATA Thaxter. Plate I, figs. 32-39; Plate II, figs. 5, 7, 8, 13-18; Plate XVI, figs. 1-14.

Proc. Am. Acad. Arts and Sci. Vol. XXIV, p. 10; *L. gigantea* Istvánffi, Termész. Füzet. Vol. XVIII, 1895, p. 82, Plate II.

Perithecium nearly colorless or straw yellow to almost black-brown, blackened below the apex, hyaline about the pore, more or less evenly inflated, the rather small lip-cells turned slightly outward. Appendages very variable in form, size, and color; hyaline or yellowish to deep red brown, arising from an inner and an outer basal cell; the outer bearing a single branch, rarely simple, usually once or twice branched; the inner producing two branches on either side, rarely simple, often many times successively branched forming a dense tuft; the branches rigid and distally attenuated, or flexuous, with bluntly rounded tips, slender or stout, rather closely septate. Antheridia solitary, or borne in pairs laterally or terminally, on sometimes densely crowded branchlets. Receptacle short and rather stout, or very elongate; normal in form, hyaline or distally suffused with brown. Spores, $60-100 \times 5-8 \mu$. Perithecia, $110-240 \times 35-95 \mu$. Longest appendages, $180-750 \mu$. Total length to tip of perithecium, $300-800 \mu$ (1200μ sec. Istvánffi).

On *Platynus cincticollis* Say, *P. extensicollis* Say, *P. melanarius* Dej., *P. ruficornis* Lec., *P. picticornis* Newm., *P. bicolor* Lec., *P. Pusillus* Lec., *P. dissectus* Lec., *P. brunneomarginatus* Mann., *P. floridanus* Lec., *P. ovipennis* Mann., *P. sinuatus* Dej., *Anisodactylus baltimorensis* Say, Maine to Florida and California. On *Colpodes purpuripennis* Chaud., *C. cæruleomarginatus* Chaud., *C. duplex* Bates, *C. grata* Bates, *C. petilus* But., *C. incultus* Bates, *C. sphodroides* Chaud., *C. cyanonotus* Chaud., *C. tenuicornis* Chaud., Mexico and Central America. On *Platynus* (?) sp., Japan. On *Limosthenes (Pristonychus) cavicola* Sch., *Platynus ruficornis* Goeze, Europe. On *Macrochilus biguttatus* Goeze, Liberia, Africa.

In this species I have included a large series of specimens from various parts of the world which, though varying very greatly in form and size, appear to be identical, since every imaginable gradation exists between the more extreme types. The figures of *L. flagellata*, given by Peyritsch, which it most nearly resembles, are so bad that, without a knowledge of the host, it would be impossible to determine the species with any certainty. His fig. 2, for example, if correctly drawn, would belong to a quite different type, and his fig. 6 is undoubtedly the young condition of very different and undescribed form. It may be noted further that although *Bembidia* occur abundantly associated with the species of *Platynus*, on which the present species is parasitic, I have never found a specimen on the former host. Whether it should not be united with *L. anceps* is another question which only the examination of European material can determine, as

it is not clear from Peyritsch's account in what respects this species differs from *L. flagellata*. The only peculiarity of the former species appears to be that cell III is unusually elongated; yet this may have been accidental or due to careless reproduction. That the typical *elongata* occurs in Europe on *Platynus* (*Anchomenus*) as well as on *Pristonychus cavicola* is an undoubted fact, the *L. gigantea* of Istvánffi being identical with the most typical forms of *elongata*, and the material which I have seen derived from species of *Platynus* taken in the neighborhood of Vienna, seems also not separable from the same form. The retention of the species as distinct from *L. flagellata* and *L. anceps* is therefore provisional, and it may prove that all three are the same.

The variations of *L. elongata*, which are very numerous and are in part represented on Plate XVI, appear to be due in part to the character of the individual host attacked and partly to the position in which the plant grows; this species illustrating better than any other the variations which have been previously alluded to (p. 240) as dependent on these circumstances. In brief, the species may be very elongate (more than a millimetre in length from the foot to the apex of the perithecium) or very short (300 μ or even less) and stout; in color it may vary from pale straw color to deep brown, specimens sometimes occurring that are nearly opaque; the appendages may be short and stout or very long and slender, sometimes almost simple, in other cases very densely branched, hyaline or opaque, yet conditions showing every gradation between these extremes are so numerous as to render the separation even of varieties impossible.

One of the short stout varieties that occurs on the legs of *Platynus cincticollis* was formerly thought by me to be a form of *L. Rougetii*, but it seems certain that this variation is merely due to the position of growth, since it occurs also on the jaws of the host as well as when the parasite grows crowded at the tips of the elytra. The type-form is that which grows as a rule near the base of the legs on the inferior surface of the thorax, and is represented in fig. 4, Plate XVI. It is one of the commonest of all the species as well as the most widely distributed, and it is to be hoped that its great variability will not lead to an extended synonymy in the future.

LABOULBENIA FLAGELLATA Peyritsch.

Peyritsch Sitz. d. Wien. Acad. LXVIII, p. 247, Plate I, figs. 1-3; Sorokin Veg. Paras. Vol. II, p. 415, Plate XXXII, fig. 765; Winter's Pilze Deutsch. II, p. 921; Berlese, Malpighia, III, p. 55; also in Saccardo Sylloge Fung. Vol. VIII. p. 910.

"Light yellowish brown, only the mamilla of the perithecium blackish about its base; pseudoparaphyses few in number (4-7), about equal, simple or divided at the base, colorless, for the most part exceeding the perithecium in length."

On *Bembidium lunatum* Duft., *Anchomenus albipes* F., *A. marginatus* L.

The above description is taken from Peyritsch, but is quite inadequate as a means of determining the species; which, as has been previously mentioned, may have to be united with *L. elongata*. I have never in my own experience seen any species like it on members of the genus *Bembidium*.

LABOULBENIA ANCEPS Peyritsch.

Sitz. der Wien. Acad. LXVIII, p. 247, Plate I, fig. 7; Sorokin, l. c. p. 416, fig. 758; Winter, l. c. p. 922; Berlese, l. c. p. 56; Saccardo, l. c. p. 911; Thaxter, l. c. Vol. XXVIII, p. 176.

"Light yellowish brown; pseudoparaphyses in small numbers, bent, about as long as the perithecium and colorless."

On the legs of *Anchomenus viduus* Pz., vicinity of Vienna, Austria.

As in the previous instance, this species cannot be determined from published data. It seems peculiar from the elongation of cell III, but is otherwise without characters which would distinguish it. It may have to be ultimately united with one or both of the preceding species.

LABOULBENIA PAUPERCULA Thaxter. Plate XIII, figs. 24-27; Plate I, fig. 9.

Proc. Am. Acad. Arts and Sci. Vol. XXIV, p. 269.

Becoming more or less deeply suffused with olive brown. Perithecium often irregularly bent, its lip cells prominently distinguished, distally nearly truncate. Appendages arising side by side in a plane at right angles to the usual position, so that there appears to be but one appendage, the larger (outer) usually once branched above its sub-basal cell, the smaller (inner) consisting of a small basal cell bearing usually two short branches more commonly simple, and bearing small groups of antheridia. Receptacle rather small; hyaline, becoming more or less deeply suffused with brown, except the lower part of the rather large basal cell; cell V twisted out of its normal position and only visible on one side, as a rule. Spores, $45 \times 4.5 \mu$. Perithecia, $100-120 \times 40 \mu$. Appendages, longest, $250-350 \mu$. Total length to tip of perithecium, $160-222 \mu$.

On *Platynus extensicollis* Say, *P. ruficornis* Lec., *P. melanarius* Dej., and *Platynus* spp. *indet.*, Maine to Virginia.

This small species appears to be constant in its characters, and is at once separable by the twist which involves the basal and insertion cells of the appendages as well as cells (IV) and (V) of the receptacle, and which would lead one to suppose, at first sight, that the plant had but one appendage, as was stated in the original description. It usually occurs on the thorax of its hosts and on the adjacent bases of the elytra.

LABOULBENIA RIGIDA Thaxter. Plate XV, figs. 16-17.

Proc. Am. Acad. Arts and Sci. Vol. XXX, p. 475.

More or less deeply tinged with olive brown. Perithecium becoming almost or quite opaque, somewhat inflated, a slight depression at its base above the more or less bulging terminal portion of the receptacle, its apex stout, snout-like, bent slightly inward. Appendages arising from two basal cells, the outer of which gives rise to a single simple or rarely once branched rigid branch, tapering slightly or nearly cylindrical; the inner producing two similar somewhat shorter branches almost invariably simple, and bearing near the base solitary sessile antheridia. Recep-

tacle normal, sometimes rather elongate. Spores, $75 \times 55 \mu$. Perithecia, $125-150 \times 10 \mu$. Appendages (longest), 300μ . Receptacle, $185-300 \mu$. Total length to tip of perithecium (largest), 300μ .

On *Pterostichus patruelis* Dej., Maine and Massachusetts.

This species may be distinguished by its rigid habit, straight single outer appendage and the blunt, snout-like apex of its perithecium. It is one of the less well marked types of the genus, yet sufficient material from the two localities mentioned indicates that its characters are sufficiently defined to warrant its specific separation from other species of the *flagellata* type.

LABOULBENIA PTEROSTICHI Thaxter. Plate XVI, figs. 18-21.

Proc. Am. Acad. Arts and Sci. Vol. XXVIII, p. 166.

Hyaline, becoming more or less, often deeply, suffused with olive brown. Perithecium becoming deeply suffused, the outer margin commonly straight, the apex rather coarse-lipped, the lip cells hyaline about the pore, more or less blackened below. Outer appendage consisting of a large basal cell, above which it is usually two to three times successively dichotomously branched, the ultimate branches long, straight, tinged, especially the outer ones, with reddish brown, the outmost often irregularly branched. Inner appendage consisting of a small basal cell, giving rise to from one to three short branches, bearing one to several fertile branchlets, sometimes also to one or more long sterile branches. Receptacle normal, usually elongate. Spores, $75-80 \times 6.5 \mu$. Perithecium, $130-160 \times 48-55 \mu$. Appendages (longest), 725μ , average, $400-500 \mu$.

On *Pterostichus adoxus* Say, and *P. luctuosus* Dej., Maine; *P. mancus* Lec., and *P. relictus* Newm., Southern States. On *Anisodactylus nigerrimus* Dej., vicinity of Cambridge.

This species is very closely allied to *L. elongata* and also to *L. polyphaga*, of which it may prove to be a mere variety. In some cases, especially in the variety on *Anisodactylus*, which is very large (about 730μ to the tip of its perithecium), the inner appendage may be more or less copiously branched. As a rule, however, in the typical form the inner basal cell of the appendage bears two short branches often less well developed than those shown in fig. 18, and bearing a variable number of branchlets which bear the antheridia terminally in pairs (fig. 20), the whole sometimes forming a short, dense tuft, as in *L. polyphaga*. The species usually grows densely crowded on all parts of the host, including the extremities of the legs, where they do not appear to vary greatly.

LABOULBENIA POLYPHAGA Thaxter. Plate XV, figs. 18-21.

Proc. Am. Acad. Arts and Sci. Vol. XXVIII, p. 165.

Perithecium hyaline, becoming more or less deeply tinged with brown, rather narrow, the outer edge nearly straight, with a more or less well marked prominence below the apex; the tip prominent, rather narrow, bent outward, deep black, hyaline about the pore, with brown shades more or less well marked below the tip and about the lower half. Appendages two, the outer consisting of a large basal cell, which may be continued directly to form a long, simple, straight

appendage distinctly constricted at the joints, or may be more or less copiously branched. The inner basal cell bears one or two short branches, from which arise small dense clusters of brownish antheridia, and rarely a more elongate sterile branch. Receptacle rather slender, a more or less well marked brown suffusion usually present in the distal portion; sometimes wholly suffused with brown. Spores, $45 \times 4 \mu$. Perithecia, average, $85 \times 30 \mu$. Appendages, longest, 300μ . Total length to tip of perithecium, average, 200–220 μ .

On elytra of *Olisthopus parmatus* Say, *Stenolophus limbalis* Lec., *S. fuliginosus* Dej., *Badister maculatus* Lec. (Texas); *Harpalus pleuriticus* Kirby, *Bradycellus rupestris* Say, *Agonoderus palipes* Fabr., Maine to Texas. A carabid near *Stenolophus*, Brazil, and *Amara* sp., Liberia, Africa.

This form, although presenting no striking peculiarities of structure, seems sufficiently well defined to warrant its separation as a distinct species. It is nearly allied to *L. Pterostichi*, and may prove a variety of this species. A form apparently identical with it occurs on several species of *Loxandrus* from Florida and Texas. The specimens on *Badister* are more or less evenly suffused with brownish yellow. It varies very greatly in the character of its outer appendage, which may be quite simple, as in fig. 18, or may often be rather copiously branched, resembling almost exactly the outer appendage of fig. 13 (*L. terminalis*); its ultimate branches, however, are never as long as in this species. Its antheridia are usually densely clustered in a tuft, the inner appendage only rarely producing elongated sterile branchlets. The perithecia are almost invariably blackened externally near the base, and usually bulge slightly at this point, as indicated in the figure which represents only the more simple type. The affected hosts are found in various situations, under stones or in rubbish, very often in rather dry situations. The determination of the specimens on *Amara* is not yet quite definite, since they vary slightly from the American form.

LABOULBENIA TERMINALIS Thaxter. Plate XV, figs. 13–15.

Proc. Am. Acad. Arts and Sci. Vol. XXX, p. 475.

Perithecium deeply suffused with smoky brown, slightly inflated, the inner margin evenly curved outward, the outer more nearly straight, but bent abruptly outward to the large prominent apex, the lips of which are well defined and outwardly oblique. Appendages arising from two basal cells, a very large outer and a much smaller inner; the outer giving rise to two cells, each of which bears terminally from two to three long, slender, tapering, flexuous branches tinged, at least basally, with reddish brown; the inner bearing a single cell, as a rule followed by two terminal cells which give rise to groups of two or three rather slender sessile antheridia; insertion cell placed just below the middle of the perithecium. Receptacle pointed below, broad above, nearly hyaline or evenly tinged with brownish, cell VII slightly prominent below the perithecium. Spores, $55 \times 5.5 \mu$. Perithecia, $120\text{--}150 \times 45\text{--}50 \mu$. Receptacle, 200–220 μ . Total length to tips of perithecium, 275–340 μ .

On *Pterostichus luctuosus* Dej., Maine and Massachusetts.

This species occurs in tufts at the tips of the elytra or abdomen, apparently never elsewhere. It is allied to forms of *L. polyphaga* and *L. Pterostichi*, from which it is at once distinguished

by its perithecium, the broad apex of which is peculiarly flattened and bent strongly outward. It is comparatively rare, and does not appear to vary to any extent.

LABOULBENIA CONTORTA Thaxter. Plate XV, figs. 1-5.

Proc. Am. Acad. Arts and Sci. Vol. XXVII, p. 42.

More or less suffused with reddish brown. Perithecium becoming suffused with blackish brown, sometimes quite opaque; outwardly inflated, its tip turned strongly outward, the lip-cells forming a very broad and characteristic hatchet-shaped apex, its edge becoming almost vertical, the whole perithecium somewhat twisted and bent toward the appendages, its axis crossing theirs in mature individuals about at right angles. Appendages arising from two basal cells, the outer large, elongate, giving rise to a single appendage once branched or simple; the inner half as large, producing usually two simple branches, each usually producing a single pair of antheridia. Receptacle rather elongate, abruptly expanded above cell II; cells I-II forming a long, nearly cylindrical, stout stalk, rather abruptly contracted at the foot; cells IV-V elongated and twisted so that the appendages and their insertion cell are often carried across at right angles to the axis of the perithecium. Spores, $75 \times 5 \mu$. Perithecia, $150-180 \times 60-75 \mu$. Total length to tip of perithecium, $330-400 \mu$; greatest width, $90-100 \mu$. Appendages about 300μ .

On *Platynus extensicollis* Say, and *P. affinis* Kirby, Maine to Virginia.

This curious species is very constant in form, and is abundantly distinct from any other species of the *flagellata* type. It is at once distinguished by the hatchet-shaped apex of its perithecium and the peculiar distortion which grows more marked in older specimens. The species is a rare one, and is found almost invariably on the inferior lateral face of the prothorax of its host, usually on the right side.

LABOULBENIA GIBBEROSA Thaxter. Plate XV, figs. 6-8.

Proc. Am. Acad. Arts and Sci. Vol. XXVII, p. 43.

More or less faintly tinged with reddish brown. Perithecium short, stout, expanding slightly from the base to a conspicuous external hunch just below its broad, almost truncate apex. Appendages arising from a large outer and a very small inner basal cell; simple or bearing two to three branches, always above the sub-basal cell, constricted at the septa, the segments becoming slightly inflated, the tips usually curved and tapering: the disk of insertion small and thick. Receptacle elongate, strongly twisted above cell II, the twist continued by cells IV and V, which are much elongated, and carry the appendages out at right angles to the axis of the perithecium. Spores, $50 \times 4.5 \mu$. Appendages, 180μ . Perithecia, $125 \times 50 \mu$. Total length to tip of perithecium, $500-550 \mu$.

On *Platynus extensicollis*, New England.

A number of specimens of this rare and singular species show that the twisted receptacle is a constant character, which is sometimes carried to such an extreme that the ordinary direction of the appendages is reversed; the elongation and curvature of cells IV and V bending them toward the base of the receptacle. The species is large and unusually elongate, growing on the

inferior surface of its host, near the base of the middle pair of legs. Specimens from York, Maine, and the vicinity of Cambridge indicate that the species is very constant and well marked.

LABOULBENIA VULGARIS Peyritsch. Plate XIII, figs. 1-3.

Peyritsch, Sitz. der Wien. Acad. Vol. LXVIII, p. 248, Plate II, figs. 17-26; Sorokin, Veg. Paras. of Man, etc, Vol. II, p. 417, Plate XXXII, figs. 760, 764, 766-769; Winter, Die Pilze Deutsch. Band. II, p. 920, fig. 1, 922; Berlese, Malpighia, Vol. III, p. 56; Saccardo Sylloge, Vol. VIII, p. 912; Thaxter, Proc. Am. Acad. Arts and Sci. Vol. XXVII, p. 44.

Hyaline, becoming more or less suffused with blackish brown. Perithecium becoming blackish, usually rather narrow, its apex large and blunt, commonly bent outward. Appendages consisting of two basal cells, the outer usually much the largest; the single outer appendage usually simple, or bearing two or three usually simple branches from its second or third cell; the inner producing usually two very short branches; the insertion-cell placed opposite the middle of the perithecium. Receptacle often rather elongate, the basal and sub-basal cells forming a stalk, rather abruptly widened distally, and colorless or more or less suffused about the septum. The distal portion of the receptacle also more or less suffused. Spores, $54 \times 4 \mu$. Perithecia, $110-150 \times 44-48 \mu$. Appendage, longer, 185μ . Total length to tip of perithecium, 220-300 μ .

On *Bembidium mexicanum* Dej., *B. lævigatum* Say, and many undetermined species; Maine to Washington and Mexico; on *Trechus chalybeus* Mann., California; on *Bembidium littorale* Pz., *B. lunatum* Duft., *B. fasciolatum* Duft., *B. punctulatum* Drap., *B. obsoletum* Dej., *B. Andreæ* Sch., *B. flammulatum* Clair., *B. decorum* Pz., *B. femoratum* Sturm, *B. bipunctatum* Duft., Europe.

The species of *Laboulbenia* which occur on members of the genus *Bembidium* are in need of further study than I have been able to give them; and since they are very apt to occur in a rather imperfect condition, it is a matter of some difficulty to classify any considerable amount of material that has been obtained from this source. From my own materials I have selected this form to represent the present species; since, although it is not at all certain that it is the only one which Peyritsch included under this name, it is certainly one of the forms that he had before him in drawing his figures. It is characterized by its stout outer appendage, which may be quite simple, or may produce a small group of short, stout branches above its third cell. The two figures represent typical specimens, the one (fig. 2) from *B. mexicanum* collected in Mexico, the other from *B. lævigatum* from Kansas. Specimens in my possession from *B. Andreæ* taken in Austria, and from an undetermined species from the Province of Quebec collected by Dr. Richards, do not differ in any respect from the form which is everywhere common on various species of this beetle. Certain forms occur, nevertheless, which seem to some extent intermediate between this species and that subsequently described as *L. pedicillata*, which may also have been seen by Peyritsch and confused by him with *L. vulgaris*. That he had no very distinct idea of the distinguishing characters of his species is indicated by his assertion that he had observed it on the staphylinid beetle *Deleaster dichrous*, which is most improbable. The two species last mentioned are readily separated by the relation in position in either case between the insertion cell and the base of the perithecium, indicated in the figures, even if other more important distinctions like the character of the appendages and the form of the perithecium were not available for this purpose. The figures given in the present instance are not very satisfactory, the form of the perithecium not being well shown.

LABOULBENIA PEDICILLATA Thaxter. Plate XIII, figs. 4-8.

Proc. Am. Acad. Arts and Sci. Vol. XXVII, p. 44.

Hyaline, becoming more or less deeply suffused with brown. Perithecium inwardly inflated, often with a median external prominence; distally sub-conical, the tip somewhat pointed, nearly symmetrical. Appendages somewhat exceeding the perithecium; usually curved toward it; arising from two basal cells, the outer twice as large as the inner, giving rise to a branch on its inner upper side and followed above by a roundish cell, its lower septum blackish, from which are produced often two to five branches, which may be one to three times sub-dichotomously branched; the branches curved, often slightly circinate at the apex; the inner basal cell giving rise to a variable number of short branches, curved toward the perithecium. Basal and sub-basal cells of the receptacle forming an often very elongate stalk, abruptly distinguished from the distal portion; cells IV and V nearly equal. Spores, $50 \times 3.5 \mu$. Perithecia, $90-95 \times 36-40 \mu$. Appendages, $90-150 \mu$ (longer). Total length to tip of perithecium, $180-300 \mu$.

On various species of *Bembidium*, Maine to Virginia, Washington.

This species, although so distinct in its typical form, approaches *L. vulgaris* in some cases, from which, as above distinguished, it seems, however, quite distinct. The production of two branches from its outer basal cell, the much lower position of its insertion-cell, its pointed perithecium, as well as the character of cells IV and V, which are nearly equal and separated by an almost vertical septum, serve to define it. It may be mentioned that although some of Peyritsch's figures of *L. vulgaris* bear a certain resemblance to this species, none of them have the character just mentioned. The species varies considerably in the luxuriance of its appendages and in the length of its stalk-cell, specimens occurring at the base of the legs being commonly the largest. It is not uncommon on various Bembidia at the margins of ponds and streams.

LABOULBENIA CASNONIÆ Thaxter. Plate XIII, figs. 22-23.

Proc. Am. Acad. Arts and Sci. Vol. XXIV, p. 266.

Pale olivaceous, becoming olive brown. Perithecium rather small and narrow, slightly inflated, the lip-cells prominent, bent slightly outward, the pore external. Appendages hyaline, the outer especially becoming deep olive brown externally at and toward its base; arising from a larger outer and smaller inner basal cell; the outer appendage simple, tapering, rather closely septate, constricted at its lower septa, about twice as long as the perithecium; the inner basal cell gives rise to two, perhaps more, branches, short branched and bearing single antheridia laterally. Receptacle normal, cell II large, the rest small; becoming more or less suffused with brown, the distal portion coarsely, though not very distinctly, punctate in the regions most darkly colored. Spores, $35-40 \times 4 \mu$. Perithecia, $75 \times 30 \mu$. Appendages, outer (larger), 170μ . Total length to tip of perithecium, $160-200 \mu$.

On *Casnonia pennsylvanica* Linn., Connecticut and Tennessee.

About two dozen specimens of this somewhat insignificant, though rare, species, have been examined, and seem to be quite constant in their essential characters. Its simple outer appendage seems invariable, and although it might perhaps be confused with some of the varieties of

L. polyphaga, it seems decidedly distinct from this species as well as from any of the varieties of *L. elongata*. It occurs at the apex of the elytra of its host.

LABOULBENIA NEBRIÆ Peyritsch. Plate XIII, figs. 19-21.

Peyritsch, Sitz. d. Wien. Acad. LXIV, p. 455, Plate II, figs. 4-8; l. c. LXVIII, p. 249, Plate III, fig. 29; Sorokin, Veg. Par. Vol. II, l. c. 417, Plate XXXII, fig. 772; Winter, Pilze Deutsch. p. 922; Berlese Malpighia, III, p. 57; Saccardo Sylloge, Vol. VIII, p. 912; Thaxter, Proc. Am. Acad. Arts and Sci. Vol. XXVII, p. 45.

Becoming suffused with blackish brown, the perithecium and distal portion of the receptacle eventually quite opaque. Perithecium short and stout; its tip bent outward, the lip-cells with hyaline margins, not very prominently distinguished; the pore external. Appendages arising from an outer and much smaller inner basal cell; the outer simple, slender, distally attenuated, rather remotely septate, somewhat rigid, becoming brown but not opaque: the inner basal cell gives rise to one or two branches, short, bearing one or two antheridia or producing one or two long sterile branches: the insertion cell above the middle of the perithecium. Receptacle normal, the basal and sub-basal cells forming a more or less, often elongate, stalk-like base, expanding rather abruptly below the terminal opaque portion of the receptacle; both becoming brownish, but not opaque, the basal cell often tapering below. Spores, $75 \times 7.5 \mu$. Perithecia, $118-166 \times 44-66 \mu$. Average, $55 \times 150 \mu$. Appendages, longest, $370-550 \mu$. Total length to tip of perithecium, $260-555 \mu$. Average, $310 \times 92 \mu$.

On *Nebria brunnea* Duft., and *N. Villæ* Dej., Europe. On *N. pallipes* Say, Nova Scotia to Virginia. On *N. Sahlbergi* Fisch, Washington, and *N. gregaria* Fisch, Aleutian islands.

This well-marked species was found in great abundance in the vicinity of New Haven, often almost completely covering the host with a thick fur. It is subject to considerable variation in size; but is otherwise quite constant in its essential characters, and is readily distinguished by the opacity of its perithecium and the broad distal portion of its receptacle, the distal cells of which become wholly indistinguishable; the high position of its insertion-cell, its single rigid outer appendage, etc. When crushed the blackened portions are seen to be very coarsely punctate. The host occurs under stones along shady brooks, and the parasite is found in the best condition in June and early September. According to Peyritsch this species was first noticed by Mayhr (1852), who considered it a pathological chitinous production.

LABOULBENIA SUBTERRANEA Thaxter. Plate XIII, figs. 9-11.

Proc. Am. Acad. Arts and Sci. Vol. XXVIII, p. 163.

More or less suffused with brown, or with two basal cells quite hyaline. Perithecium long, slightly inflated at the base, tapering more or less evenly to the large, blunt, sub-cylindrical apex, the lips of which are turned slightly outward. Appendages arising from two basal cells, the outer very large, almost covering the very small inner one, and continued directly to form the usually very large, long, simple outer appendage, which is septate, slightly constricted at the septa with a marked general constriction usually present towards the base, accompanied by a brown suffusion involving one or more cells. The inner basal cell gives rise to a single short branch bearing one or two antheridia. The black insertion-cell eventually thrust obliquely out-

ward by cell V free from the perithecium. Receptacle sometimes short, more often very long through the elongation of cell II, the distal portion reduced, usually blackish brown, while the two basal cells are hyaline. Perithecia, $135-160 \times 50 \mu$. Outer appendage, longest, 1065μ ; average, 725μ . Total length to tip of perithecium, $220-480 \mu$; average, 375μ .

On *Anophthalmus Menetriesii* Motsch., in limestone caves, Kentucky; *A. pusio* Horn, West Virginia. On *A. Motschulskyi* Schm., Carniola, Austria.

A peculiar and variable species. Forms occurring on the jaws of the host (a blind cave beetle) are short and compact, while others, especially those occurring on the lower surface of the abdomen, are very elongate. The European specimens are small and rather slender, but can hardly be separated from the American material.

LABOULBENIA PERPENDICULARIS nov. sp. Plate XIII, figs. 15-18.

L. truncata pro parte: Proc. Am. Acad. Arts and Sci. Vol. XXVII, p. 45.

Hyaline, becoming more or less suffused with olive brown. Perithecium brown, slightly inflated toward the base, the distal portion often long and narrow, the tip bent inward, its apex broad and flat. Outer appendage rigid, irregular; its basal cell long, followed by two cells, the upper smaller, often inflated, usually followed by a single cell, which bears terminally two rather short branches; inner appendage consisting of a rather large basal cell, the whole inner face of which is occupied by the bases of two long branches set one above the other, projecting across and beyond the perithecium at right angles to the outer appendage; one or both once branched near their tips and bearing a single antheridium from their basal cells. Receptacle distally rather abruptly expanded in the region of cell VI, becoming brownish, the darker distal portions sometimes obscurely punctate. Spores, $65-78 \times 5 \mu$. Perithecia, $120-150 \times 45-50 \mu$. Appendages, outer (longest), $370-400 \mu$; inner, longest, $350-450$. Total length to tip of perithecium, $250-330 \mu$.

On undetermined species of *Bembidium*, Connecticut, Virginia (Pergande), Washington (Miss Parker).

This species was at first considered a more fully developed type of *L. truncata*, which is undoubtedly its nearest ally. The differences indicated by the above description seem, however, sufficiently constant to separate it without difficulty, although it is barely possible that *L. truncata* may be the same species greatly modified by its position of growth. The peculiar mode of development by which its inner appendage is made to cross the perithecium at right angles is quite unique. The outer appendage is almost invariably broken off above its third cell, as shown in fig. 15; and the branches of the inner appendage are rarely perfect. But one of these branches (the upper) usually produces its single antheridium, the second, as well as all the portion of the first above the antheridium, being developed after fertilization. Fig. 16 represents the single inner appendage shortly before fertilization has been effected, the short terminal unicellular branch at the right subsequently growing into the elongate appendage shown in fig. 15. There is some variation in the form of the perithecium, which may be more distinctly narrow toward its extremity, and the latter may be more strongly bent inward than is shown by the specimen figured (fig. 15). The species has been observed only on or at the base of the anterior pair of legs.

LABOULBENIA TRUNCATA Thaxter. Plate XIII, figs. 12-14.

Proc. Am. Acad. Arts and Sci. Vol. XXIV, p. 267.

Dark olive brown, sometimes nearly opaque. Perithecium large, the middle third expanded slightly just above the insertion of the appendages, otherwise sub-cylindrical; the dark truncate apex slightly oblique inwardly, usually as broad as the base, with large, nearly hyaline lips about the pore. Appendages two: the outer straight, stout, dark brown at the base, unbranched, tapering to a slender, hyaline apex: the inner short, slender, simple, hyaline, its base occupying less than a third of the horizontal black disk of insertion, which is situated about opposite the middle of the perithecium. Receptacle short, wedge-shaped: cell I small, triangular, its lower half nearly hyaline, contrasting, its upper as dark as the basal portion of the outer appendage; the darker portions coarsely punctate. Spores, $55-60 \times 4.5 \mu$. Perithecia, $90-100 \times 35-40 \mu$. Appendages, outer, 150μ . Total length to tip of perithecium, $175-180 \mu$. Greatest width, 66μ .

On *Bembidium* sp., New Hartford, Connecticut.

A very small and singular species, distinguished from all others by its perithecium, which is nearly as broad at its hatchet-shaped tip as at its base. It is closely allied to the preceding species, but, as above stated, seems undoubtedly distinct. It has been found but once on an undetermined species of *Bembidium* captured at the margin of a brook in shady woods. It grew crowded on one of the anterior legs of its host.

LABOULBENIA CATOSCOPI Thaxter. Plate XVII, figs. 11-13.

Proc. Am. Acad. Arts and Sci. Vol. XXVIII, p. 164.

Pale amber brown, becoming suffused with olive brown at the base of the perithecium and in the region of cell III. Perithecium moderate, the apex rather prominent, blackened except about the pore, the blackening continued downward externally to the body of the perithecium. Outer appendage single, simple, nearly straight, exceeding the perithecium; its basal cell very large, outwardly strongly inflated and blackened. Inner appendage consisting of a much smaller basal cell, from which arise directly two branches, the latter two to three times successively branched with small basal cells and bearing a few solitary antheridia near the base. Receptacle rather elongate, normal, cell IV projecting outward beyond the rather thick black insertion cell, which is situated between the two lower thirds of the perithecium. Spores, $65 \times 5 \mu$. Perithecia, $100-130 \times 37 \mu$. Appendages (longest observed), $110-130 \mu$. Total length to tip of perithecia, $250-320 \mu$.

On *Catoscopus guatemalensis* Bates, Mexico. On *Catoscopus* spp., Liberia, Africa.

Closely resembling *L. elongata* in general form, from which it is at once distinguished by the inflated basal cell of the simple outer appendage. More abundant material may show that the measurements of the appendages given are too small. The fourteen types were obtained from the abdomen of specimens in the collection of the Museum at Cambridge. Further material derived from two species of *Catoscopus* collected by Professor Cook in Liberia is identical with the Mexican form, although the basal cell of the outer appendage is not so prominently inflated.

LABOULBENIA UMBONATA Thaxter. Plate XV, figs. 9-12.

Proc. Am. Acad. Arts and Sci. Vol. XXVIII, p. 163.

Perithecium becoming faintly, sometimes deeply, suffused with brown, projecting free from the receptacle at an angle of about 60° , the outer margin curved inward strongly to the blackish tip, the prominent ear-like lips of which are strongly incurved; a clearly defined rounded prominence on the inner side below the apex. Outer appendage hyaline, or with brown shades, consisting of a large, stout, cylindrical basal portion nearly equalling the receptacle in diameter and length, made up of a basal and somewhat shorter sub-basal cell, from the distal end of which arise two (rarely three) straight, very long and slender, tapering branches. Inner appendage arising from a very small triangular basal cell, its external wall directly continued by that of the outer appendage by which its upper surface is covered, its lower half cutting off obliquely a small portion of the large black insertion cell; its upper half producing sub-laterally a single short appendage, consisting of a single cell, bearing at its apex two rather long antheridia. Receptacle characterized by a stalk-like, slightly inflated base, made up of cells I and II, which are very large, the cells of the distal portion, except cells IV and V, very greatly reduced, so that the perithecium appears to rise almost directly from cell II. Cells IV and V elongated, carrying the broad constricted insertion cell upward, free from the perithecium; the axis of the receptacle coincident with that of the outer appendage. Spores, $60 \times 5 \mu$. Perithecia, $110 \times 59 \mu$ (including the hump which projects about 7μ). Appendages (longest), 925μ . Receptacle, $155-185 \times 18-33 \mu$.

On *Stenolophus ochropezus* Say, Kittery Point, Maine, and Cambridge, Mass.

This remarkable form is one of the most clearly distinguished members of the genus, and cannot possibly be confused with any other known species. In old specimens the perithecium, especially its hump-like projection, may become almost black, but the fruiting plant is at first nearly hyaline. The lip-cells of the perithecium are not symmetrical on either side, the inner cell on the right side terminating in a rounded, ear-like tip, that on the left side being longer and narrower. The trichogyne is simple or sparingly branched, slender, and in one specimen spirally coiled toward its tip. The species has been found only on the inferior lateral face of the prothorax of its host on the right side. The beetle is common under stones about ponds, but the fungus seems decidedly rare.

LABOULBENIA LEPIDA nov. sp. Plate XIV, figs. 7-10.

Perithecium projecting at an angle to the axis of the receptacle and appendages, hyaline, becoming more or less deeply tinged with smoky brown; the apex blackened, the suffusion extending lower externally; rather evenly inflated, the tip bent strongly outward, the lip-cells prominent, hyaline-tipped, compressed around the pore. Outer appendage consisting of a large basal cell bearing two branches, their basal cells about equal, symmetrically placed and producing each two branchlets, symmetrically divergent, long, slender, somewhat flexuous, hardly tapering and simple. The inner appendage consists of a very small basal cell, from which arise one, usually two, branches, slender, short, once or twice branched, bearing a small number of

antheridia terminally or laterally. Receptacle long and slender, but slightly expanded distally, the large basal and sub-basal cells forming a sub-cylindrical stalk. Spores, $46 \times 7 \mu$. Perithecia, $110-125 \times 50 \mu$. Appendages (longest), 425μ . Total length to tip of perithecium, $300-330 \mu$.

On *Anisodactylus nigerrimus* Dej., Cambridge, Mass.

This graceful species was at first taken for a variety of *L. elegans*; yet it seems so constant in its differences that I have concluded to distinguish it as a separate species, the structure of the tips of its perithecium (fig. 8) being its most essential character. Its slender, flexuous appendages, from their form as well as from their mode of branching, also serve as a means of distinguishing it, and seem to vary but slightly from the type represented in the figure. Its position on the host is, singularly enough, exactly the same as that occupied by its near ally, *L. elegans*. It has been found in a single locality only, near the margin of Fresh Pond, where a dozen or more infested hosts have been from time to time obtained.

LABOULBENIA ELEGANS Thaxter. Plate XIV, figs. 3-6.

Proc. Am. Acad. Arts and Sci. Vol. XXIV, p. 13.

Hyaline, becoming finally more or less tinged with yellowish brown. Perithecium more or less inflated, abruptly constricted below the deep black apex, the lip-cells very prominent, bent strongly outward from a rounded inner jet-black prominence to the hyaline tips, mouth-like about the pore. Outer appendage arising from a rather large basal cell, above which it produces two branches, the outer simple, rigid, divergent, tapering, the inner producing from its basal cell two branches symmetrically divergent, long, rigid, simple, and tapering: the inner appendage arising from a small basal cell, which produces usually a single branch on either side which may be several times irregularly branched, the branchlets fertile, bearing a few antheridia, singly or in pairs or sterile, often falcate, peculiarly inflated toward the middle and constricted at the septa. Receptacle but slightly expanded distally, the sub-basal cell stouter than the basal, the two usually somewhat inflated and suffused in the region of their common septum. Spores, $40-50 \times 4-5 \mu$. Perithecia, $110-150 \times 50-65 \mu$. Appendages, longer, $250-400 \mu$; inner, $50-75 \mu$. Total length to tip of perithecium, 290μ (larger, 335μ).

On *Harpalus pennsylvanicus* DeG., New England.

A common and very pretty species, though more stiff and less graceful in its habit than the preceding. It is one of the few forms in which the branching of the outer appendage is almost, though not absolutely, invariable. It is at first perfectly colorless, becoming brownish only in very old individuals, and is very constant in form. It is confined to the lateral face of the prothorax of its host on the right side, where it forms a rather compact tuft just below the projecting margin; but very rarely it occurs, sometimes in company with *L. conferta*, on the corresponding left side, and has been once noticed on the anterior legs. The host is very common, and may be found in late August and early September, devouring the pollen of the common rag weed (*Ambrosia artemisiæfolia*) in open fields.

LABOULBENIA CONFERTA Thaxter. Plate XIV, figs. 12-14.

Proc. Am. Acad. Arts and Sci. Vol. XXIV, p. 268.

Hyaline or tinged with smoky brown, the base of the perithecium and the adjacent cells often dark brown. Perithecium straight, short and broad; tapering rather suddenly towards the apex, which is black except about the hyaline pore, the lip-cells coarse, blunt, turned very slightly outward. Appendages hyaline or brownish; the outer much the largest, its basal cell twice as large as that of the inner, and giving rise typically to three branches, themselves once or twice two- to three-branched above their basal cells; the inner similar but smaller; both the outer and inner varying to more simple forms; insertion cell small, very slightly oblique, placed slightly above the base of the perithecium. Receptacle normal. Spores of usual type, $50 \times 16 \mu$. Perithecium, $130 \times 60 \mu$. Appendages, maximum, 300μ . Total length to tip of perithecium, 300μ ; greatest breadth, 70μ .

On *Harpalus pennsylvanicus* DeG., New England.

Except for its color and the branching of its outer appendage this form might readily be taken for one of the varieties of *L. elongata*. It seems certainly distinct from this species, however, as well as from the larger *L. elegans*, with which it is rarely associated, and which it resembles in its general coloration. It usually occurs in a dense tuft on the anterior legs of its host, very rarely also on the left side of the inferior lateral face of the prothorax. Though abundant material has been examined, the species seems comparatively rare.

LABOULBENIA MACROTHECA Thaxter. Plate XVIII, figs. 5-8.

Proc. Am. Acad. Arts and Sci. Vol. XXX, p. 474.

Clear amber-yellow. Perithecium large, evenly inflated, the curvature, from base to apex nearly symmetrical on either side, the apex rather large, outwardly oblique, with a blackish basal shade; the remainder of the perithecium translucent, amber-colored, the walls thick, the spore mass large. Appendages flexuous, thick, pale amber-colored or tinged with purplish, arising from two cells, the inner small and roundish, the outer much larger, two or three times as long, usually bearing a single cell with two terminal, more commonly simple, branches; the inner producing two branches, each several times branched: the outer appendages especially more or less constricted at the septa. Receptacle small, usually short and slender, the basal cell long, narrowed towards its base, the sub-basal cell short, the remaining cells relatively small. Perithecium, $130-150 \times 45-55 \mu$. Spores, $60 \times 5.5 \mu$. Appendages (longer), 185μ . Receptacle, $150-165 \times 35-40 \mu$. Total length to tip of perithecium, 240μ (longest, 270μ), greatest width, $55-60 \mu$.

On *Anisodactylus baltimorensis* Say, Maine. On *Anisodactylus* sp. (?) Bathurst, N. B. (H. M. Richards).

This species occurs not rarely on the anterior legs of its host, less frequently on the borders of the elytra. It may be distinguished by its pale amber color, large, evenly inflated perithecium, and slender receptacle, the distal portion of which is relatively unusually reduced. Fig. 6 represents the more typical habit, the basal and sub-basal cell forming a straight, rigid

stalk, gradually expanding upward and characteristically constricted at the common septum. The species is most closely allied to *L. elongata*, but is always readily separable from this species by the characters just mentioned. Although growing exposed to unfavorable conditions near the tips of the anterior legs, it does not assume the short, compact form usually characteristic of species developed in this position.

LABOULBENIA ARCUATA Thaxter. Plate XVIII, figs. 1-4.

Proc. Am. Acad. Arts and Sci. Vol. XXIV, p. 268.

Perithecium smoky-black, becoming uniformly almost opaque; large, narrowed somewhat towards the broad, bluntly rounded, less deeply colored tip, which is nearly symmetrical or bent slightly inward. Outer appendage consisting of a rather large basal cell, from which arise one, often two, branches, which may be simple or once or twice branched; inner appendage arising from a much smaller basal cell, which produces two branches, simple or sparingly branched, bearing usually solitary antheridia laterally. Receptacle at first colorless, contrasting with the dark perithecium; but becoming slightly suffused with brown, the basal cell usually larger than the sub-basal, and strongly curved. Spores, $65 \times 5 \mu$. Perithecia, $160-185 \times 50-55 \mu$. Appendages longer, 240μ . Total length to tip of perithecium, $300-350 \mu$; average, 320μ .

On *Harpalus pennsylvanicus* DeG., New England.

This well marked and rather rare species is readily distinguished by its peculiar perithecium. It occurs, so far as I have observed, only on the broad tips of the anterior pair of legs (usually the left) of male individuals, where it is sufficiently conspicuous from its contrasting colors. Though the abundant material obtained is all from New England, the species, together with the remaining forms which inhabit the same host, are all doubtless widely distributed in the United States.

LABOULBENIA HARPALI Thaxter. Plate XIV, figs. 15-18.

Proc. Am. Acad. Arts and Sci. Vol. XXIV, p. 13.

Hyaline, becoming tinged with brown. Perithecium small, inflated below, tapering to the clearly distinguished, deep blackish-brown tip; bent sidewise from the receptacle, the lip-cells turned outward from the evenly rounded, knob-like extremity to their hyaline tips, which form a slight, pointed projection around the lateral external pore. Outer appendage consisting of a usually somewhat rounded basal cell, from which arise two branches, simple or once to twice branched, their branches rather rigid, tapering, all the cells rather short, inflated and constricted at the septa: inner appendage consisting of a small round cell producing two branches, simple or once branched below, and bearing, usually solitary, lateral antheridia. Basal cell of the receptacle sub-cylindrical, commonly longer than the sub-basal, tapering but slightly to the blunt base; the septum between the two more or less oblique. Spores, $60-68 \times 5-5.5 \mu$. Perithecia, $90 \times 40 \mu$. Appendages longer, $200-300 \mu$. Total length to tip of perithecium, 290μ ($215-300 \mu$).

On *Harpalus pennsylvanicus* DeG., New England.

This very common species is distinguished from all others by the peculiarly modified tip of its small perithecium. It grows, appressed and densely crowded, invariably on the anterior

inferior margin of the thorax and the adjacent posterior margin of the prothorax. It is subject to but slight variation, and is doubtless widely distributed.

LABOULBENIA INFLATA Thaxter. Plate XVII, figs. 4-6; Plate III, fig. 5.

Proc. Am. Acad. Arts and Sci. Vol. XXVII, p. 41.

Hyaline, becoming tinged with brown. Perithecium more or less inflated, narrowed towards the broad, blunt, often symmetrically rounded apex, becoming more or less suffused with brown, projecting outward from the receptacle. Outer appendage simple, tapering, its base made up of three short, superposed, conspicuously inflated cells constricted at the blackened septa, the distal portion more remotely septate, not inflated or constricted; the inner appendage rises from a basal cell, nearly as large as that of the outer, which gives rise to two simple, hardly divergent branches, one to three of the basal cells of which are inflated as in the outer appendages. Receptacle normal. Spores, $50 \times 4.5 \mu$. Perithecia, average, $90 \times 37 \mu$ (largest, $110 \times 50 \mu$). Appendages, longest, 185μ . Total length to tip of perithecium, $150-200 \mu$.

On *Bradycellus rupestris* Say, South Dakota (Aldrich), Kittery Point, Maine, and Waverly, Mass.; Newport, R. I. (Richards).

This very pretty and well marked species appears to be not uncommon on the above mentioned host, which is probably identical with the beetle on which the original types were found; although this was, by an oversight, stated to be a species of Bembidium. It is distinct from all other species in the character of its appendages, and could not be mistaken for any described form unless, perhaps, *L. Philonthi*, to which it bears a slight superficial resemblance.

LABOULBENIA COMPRESSA Thaxter. Plate XIV, figs. 1-2, 11.

Proc. Am. Acad. Arts and Sci. Vol. XXVIII, p. 165.

Pale yellowish. Perithecium becoming tinged with olive-brown, inflated, the lip cells compressed to form an evenly rounded, narrow, prominent apex, which is commonly bent slightly outward, and blackish brown except about the pore, which is external and lateral. Outer appendages simple or once branched above its sub-basal cell, the lower cells slightly inflated, the branches straight and tapering. From the inner basal cell arise two branches, which may be simple or once branched, the sterile branches like the outer appendage. Receptacle normal, the basal cell usually curved. Spores, $50 \times 3.7-4 \mu$. Perithecia, $85-100 \times 30 \mu$. Appendages, longest, $150-200 \mu$. Total length to tip of perithecium, $175-260 \mu$, average, 210μ .

On *Anisodactylus baltimorensis* Say, Kittery Point, Maine.

This small species in its typical form is hardly to be confused with any other by reason of its narrowly pointed perithecium; but specimens are sometimes found which indicate that it is very closely related to *L. filifera*, of which it may possibly prove to be a variety. It is almost invariably found at the base of the middle pair of legs of its host, usually at the right, rarely on the elytra, and is not very common. The spores are remarkably long and slender in proportion to the size of the perithecium. The hosts affected were found under stones about muddy ponds.

LABOULBENIA FILIFERA Thaxter. Plate XIV, figs. 19-22.

Proc. Am. Acad. Arts and Sci. Vol. XXVIII, p. 165.

Perithecium tinged with olive-brown, the apex deeply blackened, broad, more or less evenly rounded, or nearly truncate, often symmetrical. Appendages consisting of two basal cells, the inner minute, the outer large, usually followed by a sub-basal cell, from which arise two very elongate, simple, erect, rather closely septate branches, at first dark brown above their nearly hyaline basal cells. The inner appendage consists of two short, hyaline, fertile branches, one of which may produce a long and sterile branch. Receptacle short, about equalling the perithecium in length, the anterior margin rather abruptly diverging above cell II. Spores, about $50 \times 4 \mu$. Perithecia, average, $25 \times 90 \mu$. Appendages, longest, 550μ . Total length to tip of perithecium, $150-190 \mu$.

On *Anisodactylus Harrisii* Lec., *A. nigerrimus* Dej., *A. interpunctatus* Kirby, *Harpalus pleuriticus* Kirby, and *H. erythropus* Dej., Maine, Massachusetts, Pennsylvania.

A common species found usually densely crowded along the outer margin of the elytra towards their base, less frequently elsewhere. The very long outer appendage is usually broken off in part. The two specimens figured are type forms, but the tip of the perithecium is not in all cases so abruptly truncate, and the lip-cells are sometimes distinctly turned outward with a sub-hyaline area about the lateral pore. The hosts are common everywhere about ponds and in fields.

LABOULBENIA HAGENI Thaxter. Plate XVII, figs. 20-22; Plate III, fig. 4.

Proc. Am. Acad. Arts and Sci. Vol. XXX, p. 470.

More or less deeply tinged with brown. Perithecium slightly inflated, tapering to the blunt outwardly oblique apex, which is blackened below the hyaline lips. Appendages arising from an outer and an inner basal cell, the outer of which is followed by a squarish cell of about the same size, from the end of which project four rather short, rigid, slightly divergent hyaline branches, which taper to blunt tips, and, as a rule, hardly exceed the tip of the perithecium: the inner basal cell gives rise to two squarish cells, one on either side, each of which bears usually a pair of branches similar to those just described. Receptacle short and stout, normal in form, the lower portion of the basal cell hyaline. Perithecia, $55 \times 18 \mu$. Appendages (longest), 65μ . Total length to tip of perithecium, 100μ .

On *Termes bellicosus* var. *mozambica* Hagen, Africa.

The occurrence of a most typical and decidedly insignificant looking species of this genus on a larva of the worker of a species of white ant is certainly quite unexpected in view of the wide difference which exists between this neuropterous host and the usual insects infested by the genus. But for the four stiff branches arising from the sub-basal cell of the outer appendage, and suggesting the roots of a molar tooth, it would be difficult to specify its distinguishing characters unless it be the fact that it is the smallest species of the genus. The species is dedicated to the memory of the late Professor Hagen, by whom it was observed many years since on the same specimen examined by the writer, collected by Dr. Peters in Africa, from all parts of which sufficiently abundant material was obtained.

LABOULBENIA PARVULA Thaxter. Plate XIV, figs. 22-24; Plate II, fig. 10.

Proc. Am. Acad. Arts and Sci. Vol. XXVII, p. 41.

Tinged with olive, becoming deep olive brown, sometimes nearly opaque. Perithecium straight, inflated below the broad, squarish apex. Outer appendage almost opaque externally at its base, consisting of a large basal cell producing distally two branches, one terminal, the other lateral or sub-lateral, both once or twice branched above their basal cells; inner appendage consisting of a smaller basal cell which gives rise to typically two branches, each once or twice branched, the ultimate branches in both appendages rigid, sub-cylindrical, erect or but slightly divergent, slender. Receptacle stout, sub-triangular; the basal cell small, hyaline or translucent, the rest eventually nearly opaque, obscurely punctate. Spores, $40 \times 4 \mu$. Perithecia, $90-110 \times 30-40 \mu$. Appendages, longest, $110-200 \mu$. Total length to tip of perithecium, average, $180-190 \mu$.

On *Platynus extensicollis* Say, *P. aeruginosus* Dej., *P. striatopunctatus* Dej., Maine to South Carolina. On *Bembidium bimaculatum* Kirby, Washington (Miss Parker).

This small and well defined species occurs often in great numbers on the legs (usually the posterior) of its host, and not elsewhere. It was first sent me on *P. extensicollis* by Mr. Pergande, and has since been found in various localities. The appendages are, as a rule, more or less broken, and perfect specimens such as those represented in the figures are not frequently met with. When uninjured, the slender, terminal portion of the appendages is quite characteristic, but when the latter have been broken, as from the position of growth upon the host they are very likely to have been, the new branches which grow out to replace the primary ones are apt to be shorter, stouter, and without the characteristic form just mentioned. A curious development of filaments from the basal cells of a perithecium which had been partly broken off in an individual of this species, is represented in Plate II, fig. 10, and several similar instances have been observed.

LABOULBENIA SCELOPHILA Thaxter. Plate XIV, figs. 23-26.

Proc. Am. Acad. Arts and Sci. Vol. XXIV, p. 269.

Becoming more or less suffused with olive-brown except the nearly hyaline basal cell. Perithecium rather evenly inflated, the apex rather broad, the inner lip-cells prominent, bent slightly outward. Outer appendage consisting of a sub-cylindrical basal cell, producing distally a terminal and on its inner side a sub-terminal branch, the outer usually simple, the inner once branched above its basal cell: inner appendage consisting of a somewhat smaller but similar basal cell which produces two branches simple or once branched, bearing laterally several long, slender, curved antheridia; both appendages with their branches hardly divergent, sub-parallel and curved strongly towards and past the tip of the perithecium. Receptacle sub-triangular, short and rather stout, the partition between cells II and VI very oblique, the basal cell small, sub-triangular, hyaline. Spores, $50 \times 5 \mu$. Perithecia, $100-120 \times 40-50 \mu$. Appendages, longest, 180μ . Total length to tip of perithecium, $200-220 \mu$.

On *Platynus extensicollis* Say, New England.

This small species is allied to *L. parvula* in general form, but is at once separable by its stouter curved appendages. It occurs only on the legs of the host mentioned, usually in small numbers, and is very constant in its characters.

LABOULBENIA RECTA Thaxter. Plate XIV, figs. 27-28.

Proc. Am. Acad. Arts and Sci. Vol. XXVII, p. 42.

Olivaceous. Perithecium straight, rather small, symmetrically inflated, the short, almost truncate, black apex abruptly distinguished; the wall-cells distinctly spiral. Outer appendage consisting of a basal cell bearing distally a terminal and on the inner side a sub-terminal branch; each usually once branched above its basal cell: the inner appendage consisting of a much smaller basal cell, producing two branches, each of which may be once branched, the ultimate branchlets of both appendages stiff, erect or diverging slightly towards the perithecium, tapering slightly, rather closely septate and about equal. Receptacle long, straight and rather slender. Spores, $75-80 \times 6-7 \mu$. Appendages, longest, $200-250 \mu$. Perithecia, $150-180 \times 50-75 \mu$. Total length to tip of perithecium, $350-430 \mu$.

On *Platynus extensicollis* Say, Maine and Connecticut.

This rare species was found in several localities about New Haven and at York, Maine, attached to the anterior legs of its host in company with *L. scelophila*, which is, perhaps, its nearest ally; although readily distinguished by its smaller size, different shape and curved appendages. It is one of the few species in which the longitudinal series of wall-cells of the perithecium have a spiral twist.

LABOULBENIA CRISTATA Thaxter. Plate II, figs. 2-3; Plate XVII, figs. 24-29.

Proc. Am. Acad. Arts and Sci. Vol. XXVIII, p. 174.

More or less suffused with brown. Perithecium curved outward, evenly, often deeply, suffused with brown, tapering to the neck-like apex, its prominent lips turned outward, the base of the inner lip more deeply suffused. Appendages two, the outer consisting of a large, squarish cell surmounted by a sub-basal cell which bears on its upper flattened surface a series of from three to six large, straight, simple, septate dark red-brown branches set side by side antero-posteriorly in a single row, the inner very long, the outermost basally deeply blackened and contracted, curved strongly outward, its hyaline sub-erect distal portion commonly broken off. The inner basal cell very small, producing usually two short branches bearing groups of large, long-necked antheridia. Trichogyne large, branched and septate, the ultimate branches straight and tapering. Receptacle short, stout, hyaline, becoming tinged with yellowish brown. Cell I small, cell II very large, all very thick-walled. Spores, $50-55 \times 4-4.5 \mu$. Perithecia, $110-130 \times 37-45 \mu$. Appendages (outer, not including two basal cells), $90-480 \mu$, basal cells, 35μ . Total length to tip of perithecium, $250-280 \mu$.

On *Pæderus littorarius* Grav., and *P. oblitteratus* Lec., Maine; *Pæderus* sp.? Mexico and Nicaragua; *Pæderus ruficollis* Fabr., Austria.

A very well marked and in the case of well developed specimens one of the most striking species of the genus, easily recognized by the crest-like series of branches from the outer appendage, which, however, varies very considerably. The specimens from Mexico and Europe illustrate the extremes of development as far as the appendages are concerned, fig. 29 representing a specimen from the first mentioned locality. The species is rather common in dry or moist situations, the hosts being abundant in rubbish in cultivated land. It is doubtless this form which is mentioned by Rouget as occurring on *Pæderus* in France and confused by him with *L. Rougetii*. It is a distinctly isolated form, and cannot be said to be definitely related to any of the known species of the genus except the following, although an undescribed form occurs on *Bledius*, which approaches it in some respects.

LABOULBENIA DIOPSIS nov. sp. Plate III, fig. 6.

Perithecium dull amber brown, a blackish patch below the hyaline lip margins on the inner side, the inner edge rather straight, the apex large, prominent and somewhat abruptly distinguished, the insertion of the trichogyne usually conspicuous. Receptacle often very long-stalked through the great elongation of cell II; the distal portion small, compact, rather abruptly distinguished from cell II, its cells more or less uniform in size; the whole tinged with brown, the distal part more deeply. Appendages arising from an inner and an outer cell, the inner usually producing two short two- to three-celled branches bearing the long, slender antheridia; the outer followed by three cells: the lower producing from their inner side one, rarely two, superposed branches, the upper a crest-like series of branches arranged antero-posteriorly in a single row. All the branches more or less deeply tinged with brown, somewhat constricted at the septa, rarely furcate above the basal cell, often tending to grow stouter distally, the terminal cell of each bluntly rounded or tapering but slightly. Spores, about $7 \times 55 \mu$. Perithecia, $110-140 \times 30-38 \mu$. Receptacle: distal portion about $35 \times 50 \mu$. Cell II, $200-500 \times 25 \mu$. Total length to tip of perithecium, $300-800 \mu$.

On *Diopsis thoracica* Westw., Coffee Hill, Liberia, Africa (O. F. Cook).

This curious form, which was first observed on its singular host by Professor Cook, is the first species of the genus which has been found on a dipterous insect, in the present instance a fly with stalked eyes, and, according to Professor Cook, with riparian habits. It seems in general to be subject to little variation except in the length of cell II, which may be greatly elongated. In the general form of its perithecium and receptacle it recalls to some extent *L. subterranea*; but it is undoubtedly more closely related to *L. cristata* than to any other species, as is indicated by the form of its appendages and antheridia, as well as by the outline of its perithecium. The types were found on the legs and abdomen as well as on the eye stalks of the host on which, from their length and dark color, they are quite conspicuous.

LABOULBENIA BRACHINI Thaxter. Plate XX, figs. 1-8.

Proc. Am. Acad. Arts and Sci. Vol. XXVII, p. 40.

Amber yellow, becoming more or less suffused with amber brown. Perithecium rather small and stout, somewhat inflated, the apex deep black, large, bluntly rounded. Appendages

consisting of two basal cells, the outer becoming blackened, bearing terminally a variable number of branches arranged in a single antero-posterior fan-like series; the branches mostly furcate near the base, the inner producing short, somewhat specialized antheridial branchlets, bearing terminally two to five antheridia. Receptacle variable, often short and stout, sometimes elongate, normal in form. Spores, $75-85 \times 8 \mu$. Perithecia (average), $165 \times 75 \mu$. Appendages, longest, about 375μ . Total length to tip of perithecium, $150-650 \mu$. Average, 525μ .

On *Brachinus*, several species, Maine to Texas. On *B. mexicanus* Dej., Oaxaca, Mexico.

This well marked form, although subject to very considerable variations in size, shape and in the character of its appendages, can hardly be confused with any other species. In exceptional cases the appendages are comparatively simple, as in fig. 2, in which the inner basal cell bears two ordinary branches in the usual way, but in the great majority of cases this cell becomes proliferous from its inner upper angle, each successive proliferation resulting in a branch, the resultant groups of branches forming, with the outer appendage, a crest-like series (figs. 1 and 3) of very characteristic appearance. The appendages are very apt to be broken, especially the outmost branches, which are often deeply blackened (fig. 3). When growing on the legs and jaws the specimens are usually very small and stout (fig. 1); but on other portions of the host very elongate forms often occur. The species is by no means uncommon, and has been found in numerous localities about Cambridge and Kittery (Maine). In two specimens from the last locality, fine trichogynes were obtained which are copiously branched, many of the terminal branchlets having a spiral habit and ending in a distinct knob-like enlargement. The antheridial branchlets, although not as highly developed, recall those of *L. variabilis* which, however, does not seem otherwise nearly related. The hosts are more often found under stones about ponds and streams, and are recognized by their habit of discharging a cloud of pungent vapor when disturbed.

LABOULBENIA ZANZIBARINA Thaxter. Plate XVII, figs. 1-3.

Proc. Am. Acad. Arts and Sci. Vol. XXVIII, p. 175.

Olive brown, the basal cell nearly hyaline. Perithecium rather large, more deeply colored below the somewhat suffused tips of the lip-cells, the latter not prominently distinguished, forming a slightly enlarged, broad, somewhat flat-tipped, almost straight apex. Appendages consisting of two basal cells, the outer producing externally a single obliquely vertical series of branches, their basal cells inwardly concave and bearing externally a secondary series of branchlets arising like the primary ones and producing branchlets of the third order: the inner basal cell producing similar shorter series of branches on either side; the branches, like those of the outer appendage, some of them producing antheridial branchlets bearing a terminal row of antheridia; all the ultimate sterile branchlets of both appendages similar, cylindrical, bent slightly towards the perithecium. Receptacle becoming nearly opaque, its dark portions distinctly punctate, cell I hyaline, cell VI continued downward. Spores about 50μ long. Perithecia, $100-110 \times 3.7 \mu$. Appendages (longest), 200μ . Total length to tip of perithecium, $185-200 \mu$.

On *Crepidogaster bimaculata* Boh, Zanzibar, Africa.

The appendages of this curious species distinguish it from all others, and in their successive one-sided branching recall those of the genus *Teratomyces*, this one-sided habit being even characteristic of the antheridial branchlets (fig. 3). It is scarcely possible to determine in the material available whether the inner basal cell produces a series of branches on either side or only one series. Assuming that the last is true, the fundamental habit of branching is not unlike that of *L. Brachini*, although the insertion of the primary series in the latter is more nearly horizontal. The types were taken from a specimen of the host in the Museum of Comparative Zoology, growing at the tips of the elytra and on the adjacent portions of the abdomen.

LABOULBENIA GALERITÆ Thaxter. Plate XIX, figs. 9-12.

Proc. Am. Acad. Arts and Sci., Vol. XXVII, p. 39.

Perithecium becoming almost opaque, transversely punctate, elongate, sub-cylindrical, tapering rather abruptly to the blunt apex; the lip-cells turned slightly outward; the basal wall-cells forming an abruptly differentiated, clearly defined hyaline neck-like base. Appendages consisting of two basal cells, hyaline above, black below, above which rise three connected series of superposed cells; one outer and two inner, each producing from three to six single simple branches, and forming a sub-conical body: the branches, one from each cell, tapering slightly, their distal portions straight, slightly divergent, hyaline, remotely septate; the basal portion more or less suffused with blackish brown, more closely septate, the segments inflated and constricted at the blackened septa. One or two of the lower branches from the two inner series are fertile, consisting of a single cell bearing terminally a group of from two to five long-necked, slightly curved, brownish antheridia. Insertion cell broad, free from the base of the perithecium. Receptacle variable, often elongate, cells III and IV externally or almost wholly blackened and opaque, the remaining cells hyaline or with brown suffusions. Spores, $50 \times 5.5 \mu$. Perithecia $155 \times 37 \mu$. Appendages (longer branches), 350μ . Total length to tip of perithecium, 375μ . Maximum, 600μ .

On *Galerita janus* Fabr., District of Columbia (Pergande) to Alabama (Henderson); *G. atripes* Lec., Kansas; *Galerita* sp., Iowa; *G. mexicana* Dej., Mexico.

This common and well marked species is apparently widely distributed, and can hardly be confused with any other form unless it be the succeeding species; which is, however, immediately separable by the position of cell III, although in both the same more or less conical or pyramidal base gives rise to the three vertical series of branches, two inner and lateral and one outer, which are so characteristic in their appearance. In some cases the tips of these branches have a spiral twist, which is probably accidental, but otherwise the species is a very constant one. I know of no other form in which the perithecium is so conspicuously punctate, the spots being arranged more frequently in rather definite transverse lines and themselves often elongated transversely. The species occurs scattered indefinitely over the surface of its host, more often on the elytra.

LABOULBENIA DECIPIENS Thaxter. Plate XX, figs. 19-21.

Proc. Am. Acad. Arts and Sci. Vol. XXX, p. 473.

Perithecium nearly opaque, not punctate, large, slightly and evenly inflated, tapering rather abruptly to the nearly symmetrical apex; the basal wall-cells forming a short, stout, clearly-defined, hyaline neck; the septa separating the upper wall-cells, deeper blackish and spirally twisted. Appendages consisting, as in *L. Galeritæ*, of a conical cellular base consisting of one outer and two inner rows of superposed cells, each of which bears a single simple, straight, septate branch, its lower segments slightly inflated, hardly exceeding the tip of the perithecium. Antheridia blackish, with a very long curved neck, borne singly or two together from the sub-basal cell of the inner series of superposed cells. Receptacle as in *L. Galeritæ*, except that cell III extends upward nearly to the black insertion cell of the appendages, cells IV and V being wholly included by it. Color sub-hyaline, with brownish suffusions especially in the region of cells IV and V. Perithecium, $175-278 \times 55 \mu$ (smallest, $130 \times 37 \mu$), its stalk-like base, $40-55 \times 30 \mu$. Receptacle (larger), $300 \times 75 \mu$.

On *Galerita æquinoctialis* Chaud., Guatemala, and *G. nigra*, Chev., Mexico.

This species is remarkable for its close resemblance to *L. Galeritæ*. It is at once distinguished by the position of cell III and by the peculiar twist of its perithecial wall-cells, which are not punctate, as in the latter species, and differs further in the form and size of its antheridia as well as in the branches of its appendages, which are more numerous as a rule and, as far as can be determined, from the rather poor material available, much shorter. The thirty-six types were obtained from specimens in the Museum of Comparative Zoology.

LABOULBENIA MEXICANA Thaxter. Plate XIX, figs. 1-3.

Proc. Am. Acad. Arts and Sci. Vol. XXVIII, p. 171.

Pale amber-colored, the basal cell and mature perithecium more deeply suffused. Perithecium large, straight, thick-walled, the black hyaline-lipped apex abruptly distinguished, nearly symmetrical. Appendages hardly exceeding the perithecium, consisting of two basal cells, the outer giving rise to two branches, an outer usually simple, more deeply suffused, and an inner larger, once or twice branched. From the inner basal cell arise two branches on either side, once or twice successively branched, and bearing a few single antheridia laterally. Receptacle elongate, often abnormally septate, the basal cells of the perithecium large and distinct and forming a broad, more than usually well defined base. Spores, $90-100 \times 7 \mu$. Perithecia, $200-240 \times 65 \mu$. Appendages, longest, 220μ . Total length to tip of perithecium, $500-600 \mu$.

On *Galerita mexicana* Chaud., *G. nigra* Chev., *G. æquinoctialis* Chaud., Mexico and Nicaragua.

One of the largest species of the genus occurring on the elytra of its hosts, where it is conspicuous from its light color. It is of interest as affording an instance of a transitional condition between the ordinary sessile perithecium and the long-necked forms like those of *L. longicollis*, *L. Kunkeli*, and others. The lower series of perithecial wall-cells are in the present

species much shortened about the base, and in some cases show a tendency to form a stout stalk, the sub-basal series occupying almost the whole length of the perithecium. The types examined were derived from specimens in the Museum of Comparative Zoology.

LABOULBENIA MELANOTHECA Thaxter. Plate XIX, fig. 4.

Proc. Am. Acad. Arts and Sci. Vol. XXX, p. 472.

Tinged with pale reddish brown, except the nearly black perithecium. Perithecium long, straight, symmetrical, sub-cylindrical or but slightly inflated, narrowed abruptly to the symmetrical apex, its basal wall-cells elongated to form a neck-like stalk about one-fourth as long as its main body, projecting from the receptacle at an angle to its long axis towards and beyond the appendages. Appendages as in *L. mexicana*, hardly exceeding the perithecium in length, consisting of two basal cells: the outer producing an outer and an inner branch either simple or once branched; the inner producing single branches on either side. Receptacle elongate, expanding very gradually from the base, distally abruptly rounded and contracted below the insertion cell on one side and the neck-like base of the perithecium on the other. Spores, $95 \times 5.5 \mu$. Perithecium, $220-245 \times 60-65 \mu$, its neck-like base about $75 \times 30 \mu$. Receptacle about $515 \times 100 \mu$. Total length to tip of perithecium, $800-835 \mu$.

On *Galerita mexicana* Chaud., Nicaragua.

This species has been previously referred to by the writer as a possible hybrid between *L. mexicana* and *L. Galeritæ*. It seems on more careful comparison, however, to be abundantly distinct from either. The neck-like base of the perithecium formed from the elongated basal wall-cells of the perithecium lie wholly below the ascogenic cells. The eight types were found on the elytra of their host in company with *L. mexicana*.

LABOULBENIA LONGICOLLIS Thaxter. Plate XIX, figs. 5-8.

Proc. Am. Acad. Arts and Sci. Vol. XXVIII, p. 172.

Perithecium becoming suffused with dark brown, straight, thick-walled, often slightly inflated, the apex short, rather large, abruptly distinguished, black, its lips hyaline, turned slightly inward. Appendages consisting of two basal cells, the inner smaller, bearing distally two rounded cells, the upper surface of each blackened and bearing two to five branches, which arise side by side and spreading laterally may be successively and similarly twice branched, the whole having a fan-like habit, the ultimate branches usually one to three in number, either bearing two to three long-necked, straight antheridia, or sterile, somewhat elongate, straight and tapering. The outer basal cell superiorly and externally blackened, the blackened ridge extending obliquely outward and downward nearly to the base, bearing a row of closely set branches of variable number (three to five) which are successively three to five times dichotomously branched, the ultimate branches suffused with brown, straight, slender, tapering, arising from a short characteristically bent basal cell; the basal cells of all the main branches hyaline, slightly inflated inwardly, the septa black, contrasting. Receptacle large, cell V as large or nearly as large as cell IV, the neck of the perithecium about 175μ in length. Spores, $75 \times 6.5 \mu$. Peri-

thecium, $180-220 \times 50-60 \mu$. Longest appendages, 510μ . Total length to tip of perithecium, $500-780 \mu$.

On elytra of *Galerita leptodera* Chaud., Guinea; *Galerita* sp., Liberia, Africa.

The figures of this species were drawn from a small amount of very poor material found on a specimen of *G. leptodera* in the collection of the Cambridge Museum, and do not give a very good idea of the fully developed appendages. Abundant material has since been obtained from specimens of an undetermined *Galerita* collected by Professor Cook in Liberia. When perfect the species is one of the most striking of the genus in appearance from the copious development of its peculiar branches and its often greatly elongated neck. It is most nearly allied to *L. Galeritæ*, and represents the highest development of this peculiar type. The very numerous specimens examined were found for the most part on the upper surface of the hosts.

LABOULBENIA KUNKELI Thaxter. Plate XVIII, figs. 9-10.

Proc. Am. Acad. Arts and Sci. Vol. XXX, p. 471; *Thaxteria Kunkelii* Giard. Comptes Rendus Hebdom. d. Séances d. l. Soc. Biol. Sér. IX, Vol. IV, p. 156.

Perithecium blackish brown, nearly opaque, strongly curved outward, sub-cylindrical or somewhat thickened distally, tapering somewhat abruptly to the rather small, nearly truncate tip; the lip-cells distinct, the inner smaller and often slightly more prominent; the lower series of wall-cells elongated to form a hyaline, slender, cylindrical stalk somewhat shorter than the ascigerous portion above it. Appendages consisting of two basal cells; the outer becoming opaque, producing usually two branches, one external, smaller, opaque, one to three times sympodially branched, the other terminal four to nine times sympodially branched like the first in an antero-posterior plane, erect, the branchlets sub-hyaline at the tips, the whole otherwise opaque. The inner appendage consists of a basal cell, from which arise two branches, which, curving outward, diverge on either side, rarely simple, usually furcate above their deeply suffused sub-basal cell; their basal cell several times as large, inflated, sub-hyaline, suffused above and below; the secondary branches sympodially about six times branched, the branchlets like those of the outer appendage. Receptacle long and very slender, cell VI greatly elongated and very narrow, cells III and IV elongate, nearly equal, all the cells punctate or mottled with somewhat darker, transversely elongate patches, cell II often brownish or quite opaque, the opacity involving part of cell I, the remaining cells and sometimes the whole receptacle sub-hyaline or pale yellowish brown. Spores, $185 \times 14 \mu$. Perithecia (sporiferous portion), $360-585 \times 75-85 \mu$; stalk, $320-375 \times 60 \mu$. Appendages, longer, about 500μ . Receptacle, longer, 1.3 mm. Total length, longer, 2.2 mm.

On *Mormolyce phyllodes* Hagenb., Perak, E. Indies.

The twelve specimens from which the above description is derived were obtained from the specimen of *Mormolyce* originally examined by Professor Giard and kindly communicated by him, and were taken from the elytra, thorax, and abdomen near the base of the legs. In all these situations, even where mingled with the succeeding species, the present form seems to present sufficiently constant differences to justify its separation from *L. palmella*, with which it was originally confused. Although its habit and the branching and character of its appendages

is distinctly peculiar, it should, I think, certainly be referred to the present genus, since it conforms in every essential point to the type structure found throughout the series, and is less peculiarly modified in important points than very many of the remaining species. The dimensions given by Giard are much greater than those of the specimens which I have examined. The smallest specimen among these measures 1.17 mm. in length, while the largest hardly exceeds 2.2 mm. According to Giard, however, specimens of medium size measure 3.132 mm., while larger individuals may reach 4 mm. in length. In any case, however, the species is by far the largest of all the Laboulbeniaceæ, as well as one of the most striking. Both this and the succeeding form appear to be more closely related to *L. longicollis* and what may be called the *Galeritæ* group of the genus than to any other, but apart from the production of a perithecial neck the resemblance is not very close in any case.

LABOULBENIA PALMELLA Thaxter. Plate XVIII, figs. 11-20.

Proc. Am. Acad. Arts and Sci. Vol. XXX, p. 471.

Perithecium nearly straight, almost opaque, sometimes slightly inflated, its tip nearly symmetrical, truncate, its inner walls often having a corrugated appearance, the four lower wall-cells elongated and contracted to form a short stalk below and about one third as long as the ascigerous portion. Appendages rigid and but slightly divergent, arising from two small basal cells: *an outer* which gives rise to a series of two or three opaque branches placed antero-posteriorly, the inner of which alone reaches any considerable size, branching sympodially in an antero-posterior plane, the main axis opaque, successively inflated below the branchlets, which are usually about ten in number, opaque with hyaline tips; *an inner* which gives rise to a single branch on either side, consisting of a sub-cylindrical basal cell, black below, nearly hyaline above and followed by a series of sympodial branchlets like those of the outer appendage. Receptacle short, tapering rapidly to the base, wholly black and opaque with the exception of the whole or a portion of its basal cell, which may be hyaline, and is abruptly bent above the very large hoof-like haustorium or blackened point of attachment. Spores, $150 \times 12 \mu$. Perithecium, $475-580 \times 75-110 \mu$, its neck, $75-150 \times 35-65 \mu$. Receptacle, $300-400 \mu$, its greatest width, $75-100 \mu$. Appendages (longest), 500μ , the branchlets about $225-250 \times 7-8 \mu$. Total length to tip of perithecium, 1-1.1 mm.

On *Mormolyce phyllodes* Hagenb., Perak, Molucca, Java.

The writer is indebted to the late Professor Riley for abundant material of this species found by Mr. Schwarz on a specimen of *Mormolyce* in the National Museum labelled "Java," as well as to Mr. Beutenmueller, who has kindly sent material derived from a specimen in the Central Park Museum labelled Molucca, and to Professor Giard, who has also generously allowed him to examine the original specimen of *Mormolyce* from Perak, on which the types of *L. Kunkelii* were associated with the present species. The two species are very closely allied, and were found intermingled toward the base of the elytra, although the smaller was much more abundant on the flattened margins, where it presents the appearance under a hand lens of a grove of little palm-trees. The absence of any transitional forms between the two species seems to render it unlikely that they should prove merely varieties of a single form, while the

much smaller size of *L. palmella*, its wholly opaque and short receptacle, straight, short-necked, proportionately stouter perithecium, large hoof-like base, together with the absence of furcation in the main axis of the two lateral branches of its inner appendage, afford sufficient specific differences. The antheridia appear to be represented by flask-shaped bodies borne on short hyaline branches near the tips of the branchlets of the inner appendages. The trichogynes are well developed and more or less copiously branched. The very large amount of material examined indicates that this species is subject to little variation in form and is relatively constant in size.

LABOULBENIA PHEROPSOPHI Thaxter. Plate XX, figs. 13-15.

Proc. Am. Acad. Arts and Sci. Vol. XXVIII, p. 170.

Perithecium becoming suffused with blackish brown, straight, the two upper thirds free from the receptacle, rather slender, the outer margin curving abruptly inward to the base of the prominent tip, which is itself bent slightly outward, its base deeply suffused. Outer appendage slightly divergent, somewhat exceeding the perithecium, composed of usually five or six superposed cells, somewhat longer than broad, each of which gives rise externally from its upper half to a single simple short branch, tapering distally, slightly constricted near the base, where it is divided by a blackened septum: insertion-cell rather broad, black, and considerably exceeded externally by the free upper surface of cell IV. Inner appendage smaller and similar or once to twice sub-dichotomously branched above its basal cell, the lower septa blackened. Receptacle normal, cell II usually hyaline, the rest becoming suffused with olive-brown. Spores, $75 \times 4.5 \mu$. Perithecia, $150 \times 50 \mu$. External appendage, $100-150 \mu$, its branches about 50μ long. Total length to tip of perithecium, $250-500 \mu$.

On *Pheropsophus æquinotialis* Linn., and several undetermined species from South America. On *P. marginatus* Dej. var. ? from Zanzibar, and *Pheropsophus* sp. *indet.*, Liberia, Africa (O. F. Cook).

This form appears to be common on species of *Pheropsophus* from South America occurring on all parts of the host. In general form it is much like some varieties of *L. elongata*, but is at once separable by its appendages, which are peculiar both in form and method of branching. Among the hosts examined in the collection of the Museum of Comparative Zoology one labelled "*P. marginatus* Dej., var (?)" from Zanzibar, was found to bear a small number of specimens of a *Laboulbenia* apparently identical with this species except that the antheridia were long with slender necks and borne terminally in pairs on short branches. All the specimens are, however, immature, so that it is impossible to determine whether it possesses other distinctive characters. The types vary somewhat in the relative development of the inner appendage, and the form is often more slender than is represented by the figure. Additional material on *Pheropsophus* from Liberia collected by Professor Cook has since been obtained, and although the difference above noted in the antheridia is observable in these also they do not seem to be specifically distinct from the South American types, which they otherwise resemble in all respects.

LABOULBENIA PANAGÆI Thaxter. Plate XIX, figs. 17-20.

Proc. Am. Acad. Arts and Sci. Vol. XXVIII, p. 170.

Perithecium becoming wholly suffused with blackish brown, straight, thick-walled, cylindrical or slightly inflated, the apex truncate or slightly oblique outward, the outer lip nearly hyaline. Appendages arising opposite the base of the perithecium, consisting of two equally broad basal cells, the inner shorter, bearing each a single cell from which arise from three to five usually simple branches hardly exceeding the perithecium, the lower cells usually inflated, the septa blackened, as is the outer wall of the external basal cell. Receptacle normal, cells III and IV blackened externally or wholly, the suffusion becoming general in older individuals, in which the basal cells of the perithecium may become elongated to form a neck-like base free from the insertion-cell of the appendages, which becomes pushed out quite free from the perithecium by the elongation of cells IV and V. Perithecia, $100-150 \times 35-40 \mu$. Longer appendages, $250-330 \mu$. Total length to tip of perithecium, $240-330 \mu$.

On elytra and thorax of *Panagæus crucigerus* Say, and *P. fasciatus* Say, Southern United States.

Specimens occurring upon *P. crucigerus* are decidedly larger and more elongate than those observed upon the smaller species. The form belongs to the group of which *L. Galeritæ* may be taken as the type, in which the lower series of wall-cells tends to form a neck-like base. The inflated cells of the appendages recall those of *L. inflata*, but the two species are not related. The hosts affected are myrmecophilus Carabidæ, inhabiting ants' nests.

LABOULBENIA AUSTRALIENSIS. Plate XIX, figs. 13-16.

Proc. Am. Acad. Arts and Sci. Vol. XXVIII, p. 171.

Perithecium as in the preceding species, less deeply suffused and supported in older individuals by a more or less neck-like base. Appendages consisting of two closely united basal cells; the outer much the largest, and giving rise directly to two branches, the outer deeply suffused with olive-brown, the inner once or twice branched, hyaline or with suffused tips. The inner basal cell gives rise to one or two branches, simple or once or twice branched; the insertion-cell black, thick and rather narrow, placed opposite the base of the perithecium. Receptacle normal, except for the eventually neck-like hyaline base of the perithecium, hyaline, becoming suffused with olive-brown, especially in the region of cells II, III, and VI. Spores, $74 \times 5.5 \mu$. Perithecia, $110-148 \times 38 \mu$. Longest appendages, 222μ . Total length to tip of perithecium, $220-300 \mu$.

On elytra of *Acrogenys hirsuta* McLean, Australia.

This species appears to be allied to *L. Panagæi*, although the appendages are very different in character. The available material is not abundant and is in rather poor condition, yet the species seems sufficiently well marked.

LABOULBENIA COPTODERÆ Thaxter. Plate XVII, figs. 14-15.

Proc. Am. Acad. Arts and Sci. Vol. XXVIII, p. 168.

More or less suffused with faintly olive brown. Perithecium rather large, the apex, which is bent slightly outward, dark, the lateral lips forming a slight angular prominence over the lateral external pore. Appendages two, the outer single, curved outward, blackened externally or wholly opaque, giving rise from its convex side to several successive branches rather irregular in outline and often once branched above their basal cells. Inner appendage consisting of a larger basal cell, which gives rise from its apex on either side to a branch, these two branches in turn successively several times branched, but in a plane at right angles to their own; the lower cells more or less deeply suffused or externally blackened. Receptacle normal, cell II of large diameter. Spores, $40 \times 3.5 \mu$. Perithecia, $100-110 \times 33-35 \mu$. Appendages (longest), 150μ . Total length to tip of perithecium (average), 200μ .

On *Coptodera Championi* Bates, Panama.

This species does not appear to be very closely allied to any other form known to me. The appendages are not unbroken in any of the specimens, but appear to be decidedly characteristic in their mode of branching. The knob-like tip of the perithecium and the rather abrupt enlargement of the receptacle above the basal cell also render it peculiar in general appearance. The types were found along the outer margin of the hosts' elytra.

LABOULBENIA TEXANA Thaxter. Plate XX, figs. 16-18.

Proc. Am. Acad. Arts and Sci. Vol. XXVIII, p. 172.

Perithecium wholly suffused with blackish brown, short, its upper half free, the outer edge abruptly curved inward to the base of the very prominent apex, the lips of which are brown, slightly pointed. Appendages two, hyaline, almost distinct above the very broad black insertion-cell, the outer broad at the base, tapering distally, strongly curved inward, rather closely septate, a small cell opposite each septum on the convex side, bearing a single short simple branch rather closely septate, hyaline, blackened and constricted at the base, directed obliquely upward. The inner appendage similar, except that a cell is present opposite the first septum at the base on the *inner* side, which bears a single antheridium or a very short fertile branch. Receptacle abruptly expanded above cell II, cells I to VI hyaline, the rest blackish brown; cell V greatly enlarged, so as to throw the appendages outward, separating them by nearly its whole width from the perithecium, its free upper surface forming a right angle with the straight inner margin of the perithecium; cells I and II rather slender. Perithecia, $130-150 \times 65 \mu$. Appendages, $150-160 \mu$, the branches (longer), $75-100 \mu$. Length to tip of perithecium, 400μ . Greatest width, 110μ .

On *Brachinus* spp., Texas, Guatemala.

One of the most striking of all the species of Laboulbenia, the many peculiarities of which need hardly be pointed out. The tip of the perithecium is not quite so broad in all specimens as it is represented in the figure, but the species seems otherwise very constant. It was found growing on the inferior lateral surface of the prothorax of its host.

LABOULBENIA PACHYTELIS Thaxter. Plate XX, figs. 9-12.

Proc. Am. Acad. Arts and Sci. Vol. XXVIII, p. 173.

Perithecium rather small, but slightly exceeding the receptacle, suffused with dark olive-brown, becoming nearly opaque, tapering abruptly to the rather slender blackened tip, which is bent slightly outward, the nearly hyaline lips outwardly oblique. Appendages two; the outer forming a sub-conical body composed of superposed flattened cells four to ten in number, each cell giving rise externally to a single obliquely ascending, rather short, simple, stout, tapering branch, blackened at its base, where a basal cell is cut off by a contrasting black septum. The inner appendage consisting of a small basal and sub-basal cell separated by a blackened septum, the upper giving rise directly to from one to three antheridia or short sterile branches. Receptacle short or elongate, nearly hyaline or becoming distally suffused with blackish brown, normal, except for the unusual development of cell V, which extends along the inner margin of the perithecium beyond the insertion of the appendages, pushing them outward free from the perithecium. Spores, $66 \times 7 \mu$. Perithecia, $110-150 \times 50 \mu$. Outer appendage, without branches, 90μ long, the branches (longest), 180μ . Total length to tip of perithecium, $300-650 \mu$.

On *Pachytelea mexicanus* Chaud., Mexico.

This striking species is distinguished at once by its outer appendage, which cannot be mistaken for that of any other form. It is rather variable in size as well as in the structure of its receptacle and its relation to the perithecium, which is more commonly that represented in fig. 9. This individual, however, shows an abnormal septation of cell II. Numerous specimens were obtained from the legs and inferior surface of its host.

LABOULBENIA MORIONIS Thaxter. Plate XXI, figs. 19-22.

Proc. Am. Acad. Arts and Sci. Vol. XXVIII, p. 169.

Pale straw-colored throughout except for a slight blackish brown shade below the apex of the perithecium. Perithecium small, narrow, its whole inner margin connected with the receptacle, beyond which the rather truncate hyaline tip projects. Appendages inconspicuous, consisting of two basal cells, each of which may bear one to three short branches. Receptacle elongate, slender, expanding but slightly toward its extremity without any abrupt enlargement, the small blackened insertion cell carried outward with the appendages free from the perithecium. Spores, $55 \times 5 \mu$. Appendages, $40-50 \mu$. Perithecia, $110-125 \times 30 \mu$. Total length to tip of perithecium, $375-425 \mu$. Greatest width, including perithecium, 50μ .

On *Morio Georgiae* Pal., Mexico.

This singular species is distinguished by its narrow habit and small perithecium, which is so closely united to the receptacle and so slightly distinguished from it that it appears at first sight undeveloped. In some specimens the hyaline tips of the lip cells only are free beyond cell V. The appendages are almost obsolete in some instances, and are more reduced than in any other species. It seems undoubtedly allied to the species (*L. Schizogenii* and *L. Clivinae*) occurring on the allied hosts *Clivina* and *Schizogenius*.

LABOULBENIA ASPIDOGLOSSÆ Thaxter. Plate III, figs. 8, 9.

Proc. Am. Acad. Arts and Sci. Vol. XXX, p. 473.

Perithecium black, almost opaque, rather narrow, the inner margin curved abruptly outward to the rather large apex, the lips very oblique outward. Appendages arising from two basal cells which are nearly equal in size: the outer inflated and separated from the cell above it by a blackened septum, this sub-basal cell roundish, inflated, about as large as the basal cell and giving rise to two branches, an outer and an inner; the outer separated from it by a blackened septum and consisting of a basal cell with three terminal branchlets, the inner of which is deeply and broadly blackened at its base, while the other two are wholly hyaline and fertile; the inner branch from the sub-basal cell has no blackened basal septum and produces several short branchlets bearing numerous antheridia. The inner appendage, like the outer, consists of a roundish or squarish basal cell separated from a sub-basal cell by a blackened septum; the sub-basal cell producing a tuft of short branches bearing at their tips two to four antheridia or becoming more elongate and sterile. Receptacle normal, the two basal cells rather slender, elongate, colorless; the distal cells suffused with blackish brown. Perithecia, $110-120 \times 40 \mu$. Appendages (longest), 240μ . Total length to tip of perithecium, 333μ ; greatest width, 63μ .

On *Aspidoglossa subangulata* Chaud., Kansas (M. A. Barber).

A species clearly marked by the peculiarities of its appendages, which, unlike almost all other species of the genus, are fertile without regard to their external or internal origin. In this respect they resemble *L. Clivinæ*, which is found on a closely related host. Otherwise its relationship to other described species is not evident. It occurs rarely on the host mentioned, usually not more than two or three on a given specimen.

LABOULBENIA CLIVINÆ Thaxter. Plate XXI, figs. 16-18.

Proc. Am. Acad. Arts and Sci. Vol. XXVIII, p. 169.

Color pale straw-yellow to reddish. Perithecium short, stout, united to the receptacle for three quarters or more of its length; its free portion abruptly tapering to the rather small tip; the lip-cells turned slightly outward, with a blackish suffusion below on the inner side. Appendages united to form a single brush-like organ without any blackened insertion-cell, and consisting of a basal cell which may be single or longitudinally several times divided, followed by a second series of two or more elongate cells placed side by side and bearing distally a series of branches, which, by branching several times successively, form a dense tuft; the ultimate branchlets slender and curved, sterile or fertile. Receptacle moderate, normal, except that cells IV and V become irregularly divided into often numerous (four to eight) cells which vary in form, size, number, and position in different specimens. Spores, $75 \times 5 \mu$. Perithecia, $145-150 \times 55-60 \mu$. Appendage, $110-200 \mu$. Total length to tip of perithecium (longer), 400μ .

On *Clivina dentifemorata* Putz., Mexico, and *C. dentipes* Dej., Kansas (Barber).

This species is chiefly remarkable for the union of its appendages at their base into a single body and the abnormal septation of cells IV and V. The appendage is subject to great variation, and in some specimens produces great numbers of antheridia without regard to the

position of the branches. It is evidently related to *L. Schizogenii* and its allies, but cannot be confused with any described species. It appears to be a rare form and occurs scattered here and there on various parts of its host.

LABOULBENIA SCHIZOGENII Thaxter. Plate XXI, figs. 13, 15.

Proc. Am. Acad. Arts and Sci. Vol. XXVII, p. 43.

Perithecium blackish brown, deeper below the tip, sometimes nearly opaque, rather short and stout, inwardly inflated and united with the receptacle to its very tip; the hyaline extremities of the lip-cells only free, and bent slightly outward. Appendages arising from a black insertion-cell, consisting of two basal cells, which may be longitudinally several times divided, bearing distally two to several nearly hyaline branches, which may in turn be several times subdichotomously branched, the ultimate branchlets flexuous. Receptacle hyaline or straw colored, sometimes distally suffused with brown, bulging outward prominently and evenly in the region of cells III-V; cell V elongated towards the tip of the perithecium, carrying the insertion-cell outward free from the perithecium. Spores, $70 \times 5.5 \mu$. Perithecia, $100-125 \times 50-55 \mu$. Appendages (longer), 270μ . Total length to tip of perithecium, $350-450 \mu$.

On *Schizogenius lineolatus* Say, *S. ferrugineus* Putz., and *Clivina cordata* Putz., New England.

This well marked species is quite rare, never occurring in any great abundance on any single host. It is subject to but slight variations, except in the basal cells of its appendages, although small specimens like that represented by fig. 14 sometimes occur. It is most nearly related to *L. Clivinæ*. The hosts are found commonly under stones on the borders of ponds.

LABOULBENIA PHILONTHI Thaxter. Plate XXII, figs. 26-30.

Proc. Am. Acad. Arts and Sci. Vol. XXVIII, p. 174.

Perithecium rather narrow, beginning to taper almost from its base to the somewhat coarselipped apex, both margins often almost straight. Appendages consisting of two basal cells, the inner producing several (two to five) branches, which arise by successive proliferations on either side, forming two rows running side by side antero-posteriorly: the outer appendage and the branches of the inner erect, simple, rather rigid, tapering considerably, two or three of the lower septa blackened, the cells between them distinctly inflated. Receptacle hyaline or slightly suffused, normal, except that the basal cell is sometimes hoof-shaped, a portion of it blackened and continuous with the foot. Spores, $52 \times 4 \mu$. Perithecia, $160-185 \times 50-70 \mu$. Appendages (longer), 325μ . Total length to tip of perithecium, $400-450 \mu$; longest, 590μ .

On *Philonthus cunctans* Horn, *P. micans* Grav., *P. debilis* Grav., and numerous undetermined species, New England; *P. æqualis* Horn, Lake Superior; *P. furvus* Nord., California.

This species is by no means uncommon on all parts of its hosts, and may be recognized by the peculiar form of its perithecium and the rigid, erect branches of its appendages, the inflated basal cells of which recall those of *L. inflata*. The insertion-cell is not very deeply blackened, and a hyaline pointed portion is more or less distinct between and below the two basal cells of the appendages. The inner of these cells appears to become divided into a num-

ber of cells corresponding to the number of branches which it bears, the partitions running obliquely downward and inward (fig. 27). In some specimens the basal cell of the receptacle is curiously modified in a fashion (fig. 28) similar to that referred to in connection with *Compsoomyces verticillatus*; but this hoof-like structure does not appear to be either connected with any special position occupied by the plant or with any peculiarity of the host, and is much less frequent than the normal form. Many species of *Philonthus* appear to be subject to its attack, whether they occur in moist or dry situations; but the parasite rarely occurs in any great abundance on a single insect. A form allied to this, but in such poor condition that it cannot be described, was found on specimens of *Bledius basalis* Lec., collected in Florida.

LABOULBENIA CURTIPIES Thaxter. Plate XVII, figs. 16-19.

Proc. Am. Acad. Arts and Sci. Vol. XXVII, p. 40.

Becoming dark olive-brown except the contrasting hyaline basal cell. Perithecium relatively large, stout, inflated; its upper inner margin bulging strongly, the short, flat tip abruptly distinguished, bent slightly outward, the tips of the lip-cells hyaline. Appendages consisting of an outer and inner basal cell not clearly distinguishable, the outer producing several, the inner many branches sub-dichotomously branched, the ultimate branchlets slender, hyaline, somewhat or hardly exceeding the tip of the perithecium. Receptacle short, sub-triangular, distally more or less opaque, the basal cell hyaline. Spores, $40 \times 4 \mu$. Perithecia, $110-135 \times 55 \mu$. Appendages (longer), $100-125 \mu$. Total length to tip of perithecium, $200-225 \mu$.

On *Bembidium bimaculatum* Kirby, Washington.

This species occurs usually on the posterior legs of its host, and is distinguished by the peculiar form of its perithecium, in which are produced great numbers of spores. The appendages are almost invariably broken, and as no young specimens have been examined, their exact origin at the base has not been made out. The outer basal cell bears a branch terminally and probably laterally on its inner side, while a large number of branches usually arise from the inner cell on either side. The basal cells, as well as the lower cells of the branches proceeding from them, are usually so deeply suffused that the structure is obscured. The base of the trichogyne is often persistent, as in figs. 16 and 18.

This species was obtained in considerable numbers from specimens of its host sent me by Miss A. M. Parker.

LABOULBENIA CORNUTA Thaxter. Plate XIII, figs. 28-30.

Proc. Am. Acad. Arts and Sci. Vol. XXX, p. 476.

Dark blackish brown. Perithecium tapering to a broad blunt apex, from which projects a prominent straight, dark-brown appendage, unicellular, bent abruptly outward from its base, tapering slightly to its nearly hyaline rounded tip. Appendages as in *L. luxurians*, the branches fewer and stouter. Receptacle short, expanding somewhat abruptly above the sub-basal cell, the basal cell becoming narrowed and nearly hyaline towards its base. Perithecium, $85 \times 29 \mu$. Its appendage, $26 \times 7 \mu$. Total length to tip of perithecial appendage, 185μ ; greatest width, 52μ .

On *Bembidium complanulum* Mann, Washington.

The five types of this singular species are all in poor condition, the appendages being, for the most part, broken; yet it may be recognized without difficulty by the peculiar outgrowth from one of its lip-cells, which distinguishes it from all other species with the exception of *L. Gyrinidarum*, all the lip-cells of which are appendiculate in a somewhat similar fashion. It appears to be peculiar to the single species of *Bembidium* mentioned, and was found in two instances only on the margin of the right elytron near the base. The outgrowth in all the types proceeds from one of the lip-cells on the right of the pore. The infested beetles were found among material kindly collected for the writer by Miss A. M. Parker.

LABOULBENIA FUMOSA Thaxter. Plate XXII, figs. 9-20.

Proc. Am. Acad. Arts and Sci. Vol. XXIV, p. 12; Saccardo Sylloge, Vol. IX, p. 1132.

Smoky brown with a slight olive tinge. Perithecium becoming almost opaque, tapering rather gradually to the somewhat blunt tip, the lip-cells turned slightly outward. Appendages consisting of two basal cells, the outer followed by a roundish cell which, by successive proliferation on its inner side, gives rise to a number of branches; the first of which, originally terminal, becomes lateral, curved outward, blackened below, and bears several erect, usually simple branchlets. The inner basal cell produces on either side a number of branches, often once or twice branched near the base, nearly straight, erect, tapering; the whole forming a dense tuft. Insertion-cell broad, a hyaline portion projecting up between the two basal cells. Receptacle more or less tinged with brown, paler below, rather stout, never elongate, expanding gradually from below upward. Spores, $55-60 \times 5-5.5 \mu$. Perithecia, $120-130 \times 50-75 \mu$. Appendages, $75-100 \mu$. Total length to tip of perithecium, $250-325 \mu$; greatest width, $75-100 \mu$.

On *Platynus cincticollis* Say, New England.

This species is a common one always occurring at the tips of the elytra and extending to the adjacent apex of the abdomen. It is very closely allied to *L. luxurians*, which, curiously enough, grows in exactly the same position on species of *Bembidium*, but is distinguished by its large size and straight appendages. The basal cell of its outer appendage bears a proliferous cell, the first (originally terminal) branch of which becomes pushed outward by its successive proliferation, and the blackened outer half of this branch from which two to four branchlets arise vertically, is quite characteristic in appearance; the branchlets, however, usually breaking off in mature specimens. The next branch found within this primary branch may resemble it to some extent, but is more often simple, like those which succeed it. The species grows densely crowded, and I have never found it on other species of *Platynus* commonly associated with the one mentioned, which occurs in very wet situations along brooks, where it hides under stones or in wet rubbish. A species very similar to this occurs in the same situation on the elytra of *Anophthalmus tenuis* Horn in Indiana; but my material is hardly sufficient to form the basis of a diagnosis.

LABOULBENIA LUXURIANS Peyritsch. Plate XXII, figs. 1-8.

Peyritsch, Sitz. d. Wien. Acad. LXVIII, p. 248, Plate II, figs. 10-16; Sorokin Veg. Parasites, Vol. II, p. 416, Plate XXXII, fig. 762; Winter Pilze Deutsch. II, p. 92; Berlese, Malpighia, III, p. 56; Saccardo Sylloge, Vol. VIII, p. 912.

Smoky olive-brown. Perithecium tapering more or less symmetrically from its lower third to the coarse blunt apex, which is not clearly distinguished from it, one of the lip-cells forming a short but distinct pointed median projection. Appendages formed as in *L. fumosa*, but the ultimate branchlets strongly curved towards and often past the perithecium. Receptacle inconspicuously punctate, stout, the basal cell slender and nearly hyaline below, the sub-basal large, as broad as it is long, separated from cells III and VI by nearly equal oblique septa. Spores about $50 \times 4.5 \mu$. Perithecia, $110 \times 40 \mu$. Total length to tip of perithecium, 220μ .

On *Bembidium varium* Oliv., *B. bipunctatum* Duft., *B. flammulatum* Clairv. Europe. On several species of *Bembidium*, Maine, Connecticut, and Washington.

This small species is not uncommon on Bembidia about ponds and streams, though it is seldom found in great numbers or in very good condition. It grows in a small dense tuft at the tips of the elytra like the preceding species, with which it is closely allied, though readily separated by its curved appendages. The receptacle where it is suffused is rather obscurely punctate.

LABOULBENIA COMPACTA Thaxter. Plate XXII, figs. 23-25.

Proc. Am. Acad. Arts and Sci. Vol. XXVII, p. 37.

More or less suffused, not deeply, with olive-brown. Perithecium straight, tapering gradually to the rather stout tip, the lip-cells not clearly distinguished, turned slightly outward. Appendages as in the preceding species, the insertion broader, the main branches more numerous, the ultimate branchlets forming a dense tuft, rigid, erect, tapering slightly, hardly equalling the tip of the perithecium. Receptacle short and distally very broad, cells III-V about equal in size. Spores, $60 \times 4 \mu$. Perithecium, $110 \times 40 \mu$. Appendages, $90-100 \mu$. Total length to tip of perithecium, $180-190 \mu$; greatest width, 65μ .

On *Bembidium sp.*, Maine and Massachusetts.

This species, though closely allied to *L. luxurians*, seems constant, and is undoubtedly distinct. It may be recognized by its short, stout form and rigid, erect, tapering appendages, which are much more numerous than in its ally. The perithecium and receptacle are also differently shaped and never so deeply colored. It occurs not uncommonly at the base of the posterior pair of legs of its host.

LABOULBENIA CONFUSA Thaxter. Plate XXII, figs. 21, 22.

Proc. Am. Acad. Arts and Sci. Vol. XXX, p. 476.

Becoming deeply suffused with smoky brown. Perithecium rather small, inwardly inflated, the apex broad, slightly oblique outward. Appendages arising primarily from an inner and outer cell: the outer bearing a second cell which bears terminally a dense tuft of hyaline, flexu-

ous, tapering, more or less divergent branches, which are themselves more or less branched; the inner basal cell becoming several times divided and giving rise to numerous branches densely crowded and similar to the external ones. Receptacle consisting of a long sub-cylindrical basal cell, the sub-basal cell shorter and broader, cells III–V unusually large, causing this portion of the receptacle to bulge outward in an evenly rounded and characteristic fashion. Perithecia, $166 \times 55 \mu$. Appendages (longest), 150μ . Receptacle, 215μ long, its basal cell $90-110 \times 25-40 \mu$. Total length to tip of perithecium, 315μ ; greatest width, 75μ .

On *Bembidium* sp., Connecticut, Washington.

This species, although based on scanty material, seems quite distinct from its nearest allies, *L. luxurians* and *L. compacta*. Although the general arrangement of the appendages is similar in the present species, their flexuous, divergent, tapering habit is quite different from that of the two forms just mentioned, from which it is also distinguished by its larger size and peculiarly shaped receptacle. It occurs on the legs of a very small metallic-green Bembidium.

LABOULBENIA MINIMA Thaxter. Plate XXI, figs. 8–11.

Proc. Am. Acad. Arts and Sci. Vol. XXVIII, p. 175.

Punctate, suffused with olive-brown, becoming nearly opaque, except the hyaline basal cell. Perithecium becoming rounded in outline, short, nearly straight, the apex broad, truncate, coarse-lipped, distinctly punctate and nearly opaque at maturity. Appendages arising from a rounded base of insertion, composed of several cells and not distinguished from the receptacle, densely clustered, the lower segments nearly hyaline, oval or rounded, with black septa, the ultimate branches cylindrical, hyaline, strongly curved towards the perithecium. Receptacle very short and stout, the basal cell hyaline, the rest nearly opaque and punctate. Spores, $40-3.5 \mu$. Perithecia, $80 \times 40-48 \mu$. Appendages (longest), 75μ . Total length to tip of perithecia, $145-150 \mu$.

On *Callida pallidipennis* Chaud., Panama.

With the exception of *L. Hageni* this is the smallest species of the genus. The perithecium is proportionately large, sometimes very large, as in fig. 8, the distal portion of the receptacle being much reduced. The appendages resemble to some extent those of *L. luxurians*, and their original relations are clearly shown in fig. 10, the inner basal cell producing a row of branches placed antero-posteriorly on either side. The appendages are usually almost entirely broken off as in fig. 8. Abundant material was obtained from the legs and elytra of a specimen of its host in the Museum of Comparative Zoology.

LABOULBENIA QUEDII Thaxter. Plate XVII, fig. 7.

Proc. Am. Acad. Arts and Sci. Vol. XXVIII, p. 167.

Perithecium rather small, straight, suffused with brownish, darker externally just below the apex, the lips turned outward, the outer hyaline, the inner blackened. Outer appendage consisting of a rather large basal cell bearing two branches, the outer strongly curved outward, usually bearing two secondary branches from its basal cell, suffused with blackish; the

inner also similarly branched, the branches long, tapering to a blunt point, often suffused with brown near the base. The inner appendages commonly arise from two basal cells, the inmost smaller and lower in position, each giving rise to a variable number of branches, usually not more than once branched, hyaline except the outer ones, which are larger and usually suffused with brown below. Receptacle elongate. Spores about $55\ \mu$ long. Perithecium, $185 \times 50\ \mu$. Longest appendages, $370\ \mu$. Total length to tip of perithecium, $630\ \mu$.

On the upper surface of abdomen of *Quedius vernix* Lec., Illinois.

The material on which this species is based is somewhat scanty, only one of the six specimens being mature. In these the insertion-cell, with one exception, does not become wholly blackened, and seems to give rise on the inner side to a small appendiculate cell. The outmost branch of the outer appendage is deeply suffused with brown and bent outward. The large antheridia, of the ordinary form, are borne terminally or laterally, singly or in pairs, on short branchlets. The form of the perithecium, especially at its tip, is peculiar, but more abundant material is much needed to clearly define the species.

LABOULBENIA PROLIFERANS Thaxter. Plate XVII, figs. 8-10 and 23.

Proc. Am. Acad. Arts and Sci. Vol. XXVIII, p. 168.

Amber brown, often tinged with olive. Perithecium straight, but slightly inflated, amber brown or olive; the tip deeply blackened below the hyaline tips of the lip-cells, which are turned slightly outward. Appendages consisting of an outer and somewhat smaller inner basal cell, the outer producing invariably two branches, one terminal, simple, erect, slightly flexuous; the other external, sub-terminal, outwardly divergent, long, simple, deeply suffused as a rule near its base; its first septum blackened and constricted in many cases. The inner basal cell bears, as a rule, a single long, slender branch on either side, simple or with a short, fertile branchlet at its base; the antheridia terminal in groups of three to five. Within these primary appendages one to three secondary, simple, elongate appendages are produced by the proliferation of as many cells, which become cut off from the upper inner angle of cell V by oblique septa. Receptacle rather elongate, normal, except for the division and proliferation of cell V, which carries the black insertion-cell out free from the perithecium. Spores, $60-70 \times 5.5\ \mu$. Perithecia, $165-170 \times 55\ \mu$. Longest appendages, $460\ \mu$. Total length to tip of perithecium, $435-540\ \mu$.

On *Eudema tropicum* Hope, Sierra Leone; *Chlænius tenuicollis* Fabr., Syria; *C. velutinus* Duft., Algeria, *Dolichus* (?) sp., Japan.

This species is readily distinguished from all others by the division and proliferation of cell V between the black insertion-cell and the base of the perithecium. In the specimens on *E. tropicum* the external branch of the outer appendage is more sub-terminal and not blackened at its base, and the perithecia are somewhat more inflated, but there can be no doubt as to the identity of the different forms. The Japanese host is doubtfully determined, and is very likely a *Chlænius*. For the excellent Algerian material I am again indebted to the kindness of Professor Giard.

LABOULBENIA PROLIFERANS Thaxter var. *liberiana* nov. var. Plate III, fig. 7.

Like the type, but somewhat larger, the basal cell of the outer appendage always bearing a slender external branch blackened at its base. Differing from the type from the fact that the inner accessory appendage, which is usually solitary, is borne on an independent black insertion-cell free above the normal one.

On *Eudema* sp. *indet.*, Liberia, Africa.

This variety, although its peculiarity just described is constant in the considerable number of specimens which have been examined from different individuals of its host, should not, I think, be separated as a distinct species on so comparatively unimportant a character. Like the other species from this locality, the present variety was obtained from hosts collected by Professor Cook, none of which bore specimens of the normal form.

LABOULBENIA BRACHIATA Thaxter. Plate XXI, figs. 5-7.

Proc. Am. Acad. Arts and Sci. Vol. XXIV, p. 11; Saccardo Sylloge, Vol. IX, p. 1132.

Hyaline or yellowish, becoming more or less deeply suffused with smoky brown. Perithecium somewhat inflated, becoming smoky brown, deeper below the hyaline tips of the lip-cells. Appendages nearly hyaline or in part suffused with smoky brown, arising from numerous small unmodified insertion-cells, corresponding in number, except the outmost, to secondary divisions of cell V, forming an obliquely superposed series from which the appendages arise in a double row, the inner highest and usually somewhat smaller than those lower and outer in the series. Each appendage consisting of a rather large somewhat inflated basal cell, variable in size, which bears usually two branches simple or once branched, the basal cells of each branch or branchlet slightly inflated, the septa oblique and more or less blackened, the ultimate branchlets long, slender, mostly hyaline, somewhat flexuous and attenuated. Receptacle normal, except for the secondary division of cell V, which results in a superposed series of five to seven cells, decreasing in size from below upward, each opposite an insertion-cell; the lowest insertion-cell opposite a small roundish cell just above the extremity of cell IV. Spores, $60 \times 5 \mu$. Perithecia, $120-150 \times 50-60 \mu$. Appendages, longer, $700-750 \mu$. Total length to tip of perithecium, $400-590 \mu$.

On *Patrobis longicornis* Say, Maine to Virginia; on *P. tenuis* Lec., Hudson's Bay.

This fine and apparently rare species was first taken in the vicinity of New Haven, and later at York, Maine; but has never been obtained in any quantity. A single specimen of its host taken in Virginia by Mr. Pergande as well as several kindly sent me by Dr. Townsend, collected near Eastport, Me., have yielded additional material, while two specimens of *P. tenuis* from Hudson's Bay in the collection of the Museum of Comparative Zoology were also found to be parasitized. It is apparently subject to little variation, and is distinguished at a glance by the regular secondary division of cell V, which is found in no other species with the exception of *L. fasciculata* Peyr., although an approach to this condition is seen in *L. proliferans*. The antheridia are proportionately very small, and are borne usually in pairs, terminally on short one-celled branchlets (fig. 6). Whether or not the present species should be kept distinct from *L*

fasciculata it is impossible to say until we have more definite and reliable information concerning Peyritsch's species; but although his description is quite worthless, the two could not be united if one can trust his figures, by reason of the wholly different form of the appendages.

LABOULBENIA FASCICULATA Peyritsch.

Sitz. d. Wien. Acad. Vol. LXVIII, p. 248, Plate I, figs. 8-9; Sorokin, Veg. Paras. Vol. II, p. 416, Plate XXXII, fig. 757; Winter Pilze Deutsch. II, p. 922; Berlese Malpighia, III, p. 56; Saccardo Sylloge, Vol. VIII, p. 911.

"Pale yellowish brown. Appendages numerous, clustered, superposed, colorless, about as long as the perithecium." Length, $370\ \mu$.

On *Chlœnius vestitus* F., Austria.

This species corresponds essentially in structure to the preceding, except that the appendages appear to be different in character and much shorter. As already mentioned, the two may prove to be identical. A single immature example of what appears to be the same form was found on a European specimen of *Omophron limbatum* F., but is not sufficiently perfect either to figure or describe.

LABOULBENIA ARMILLARIS Berlese.

Malpighia, Vol. III, p. 52 (1889), Plate II, figs. 1-6; Saccardo Sylloge, Vol. VIII, p. 911.

"Pale brownish; with a clavulate stipe, bicellular below, above composed of a number of cells disposed in two longitudinal series, the one bearing the perithecium two-celled, rather short, the other four to six-celled, bearing the pseudoparaphyses, attenuated at its base and terminating in a black, opaque, coriaceous obconical piece, $21 \times 14\ \mu$, adhering very firmly to the host by its pointed base, $100\ \mu$ long, pale yellowish, filled with granular protoplasm; perithecium sub-cylindrical or long-ovoid, brown, terminated by a black neck furnished with a pore and a black appendage, having a few black rings, at its apex, $110 \times 36-40\ \mu$; pseudoparaphyses dichotomous or laterally almost sympodially branched, terminated by two branchlets pointed at their tips and resembling the claw of a scorpion, divided at the base of the branches by black rings or discs rather thick and coriaceous, very pale yellowish, extending to the tip of the perithecium.

"On *Antennophorus caputcarabis*, Paraguay. Total length, $290-320 \times 36-40\ \mu$."

The above description is quoted from the paper of Berlese cited, since the species is unknown to me. As far as can be determined from the published figure and description the species would seem to be related to *L. variabilis* through the multicellular insertion of its appendages. The blackened septa of the latter can hardly be considered very distinctive since they occur in numerous species and the furcate terminal branchlets may very probably be antheridia. The "appendage" below the tip of the perithecium on the inner side is undoubtedly the old base of the trichogyne (cf. Pl. XXI, fig. 12).

The chief interest of the species lies in the fact that it is the only form known to be parasitic on one of the Acarini.

LABOULBENIA VARIABILIS Thaxter. Plate XXI, figs. 1-4.

Proc. Am. Acad. Arts and Sci. Vol. XXVII, p. 38.

Nearly hyaline or suffused, sometimes deeply, with smoky brown. Perithecium straight and rather narrow, or stout and inflated; hyaline or deep smoky-brown, blackened deeply below the hyaline tips of the lip-cells, which are rather coarse and turned slightly outward or nearly straight. Appendages numerous, arising from as many small cells, which take the place of the ordinary insertion-cell, several times sub-dichotomously branched, the lower three or four septa blackened and oblique, the cells between them inflated, the ultimate branchlets straight, tapering, rather slender, erect or slightly divergent. Antheridia borne on short branchlets about the lower portion of the appendages, forming a conical cluster and arising laterally as well as terminally in variable numbers. Receptacle normal, except that cells IV and V may be distally and irregularly divided into a few small cells; short and stout or very elongate, hyaline or wholly or partly suffused with smoky brown, the darker portions punctate. Perithecia, $100 \times 225-35 \times 125 \mu$. Appendages, longest, $475-500 \mu$. Total length to tip of perithecium, 180μ to 1.65 mm. Spores, $50-75 \times 6-7 \mu$.

On *Anomoglossus pusillus* Say, *Chlenius æstivus* Say, *C. cumatilis* Lec., *C. cursor* Chev., *C. leucoscelis* Chaud., *C. floridanus* Horn, *C. pennsylvanicus* Say, *C. ruficauda* Chaud., *C. sparsus* Lec., *C. texanus* Horn, *C. tricolor* Dej., *C. viridicollis* Reiche, *Omophron americanum* Dej., *Omophron* spp. indet., *Nebria pallipes* Say, *Pterostichus adoxus* Say, *P. luctuosus* Dej., *P. corvinus* Dej., *P. caudicalis* Say, *P. Sayi* Brullé, *Patrobis longicornis* Say, *Platynus extensicollis* Say, Maine to Florida and Texas, Utah, Nebraska, Washington, California, and Mexico. On *Pterostichus* (?) sp., Brazil.

This species is remarkable for its great variation in size, even on the same host; specimens on *Pterostichus caudicalis* measuring over a millimeter and a half, while many individuals on *Omophron* are less than 200μ in length. The form and relative position of the perithecium also differs very considerably, and in one instance the tip of the perithecium scarcely exceeds cell V, being united to the receptacle throughout its length. Although their number and length varies very greatly, the species is always readily recognized by the character of the appendages and their insertion on an irregularly cellular base, which is made up partly from divisions of an original single insertion-cell and irregular terminal divisions of cells IV and V. It is a common form, occurring on all parts of its hosts, though preferring definite positions in certain cases, as for example in *Pterostichus luctuosus*, where it is usually found along the edges of the elytra, especially the left near the base. It grows usually scattered, but often rather closely crowded. It is more closely connected with the aquatic forms than any other species, unless perhaps *L. armillaris*, through the irregularity of the cells which form the base of insertion of its appendages, and affords a connecting link which renders the exclusion from the genus of the first mentioned forms quite unwarrantable unless they may prove to present essential variations in their sexual processes.

The material from South America, which was obtained from specimens of a Brazilian *Pterostichus* (?) in the Museum of Comparative Zoology, was found on the legs and on the lower surface of the thorax of the host, and although some of the specimens are peculiar in habit,

probably as a result of the position of growth, there seem to be no essential differences between this and the type forms.

LABOULBENIA OBERTHURI Giard. Plate XXII, fig. 39.

Thaxter, Proc. Am. Acad. Arts and Sci. Vol. XXX, p. 477.

Nearly hyaline except the brown or smoke-colored perithecium and sub-basal cell of the receptacle. Perithecium large, inflated towards the base, the narrower distal half abruptly rounded and contracted below a rather narrow apex with protruding lips bent outward; general color dark brown, much deeper below the apex. Appendages numerous, crowded, slender, short, the lower segments inflated, arising as in *L. Guerinii*. Receptacle elongate, consisting of a short curved stout nearly hyaline basal cell, a very long sub-cylindrical sub-basal cell, smoky brown in color, with deeper brown wart-like or scale-like scattered prominences of varying size, the remaining cells normal except that the insertion-cells of the appendages are irregularly divided. Perithecium, $300-315 \times 120 \mu$. Receptacle, 1 mm.— 900μ ; its sub-basal cell $370-425 \times 65-75 \mu$. Total length to tip of receptacle, 1.225 mm.

On *Orectogyrus heros* Reg., Madagascar.

This fine species was kindly communicated to the writer by Professor Giard, who dedicated it to M. René Oberthur, its discoverer. It is one of the largest species of the genus, its dimensions being exceeded only by *L. Kunkeli*, *L. palmella*, and the largest forms of *L. variabilis*. Although closely allied to *L. Guerinii* it is abundantly distinct and recognizable at a glance by its peculiarly modified sub-basal cell. The appendages are for the most part broken in the three specimens which constitute the types, and in more perfect examples may prove to be more highly developed than is indicated in the figure. It will be noticed that the latter is drawn with a somewhat lower combination than the other figures of the plate.

LABOULBENIA ORECTOGYRI nov. sp. Plate IV, fig. 5.

Perithecium blackish brown, nearly opaque, rather short and stout, curved, the apex well defined, the lip-cells irregularly prominent. Receptacle long and rather slender, cells I and II much elongated, the former deeply suffused distally, the latter brownish but translucent, the remainder deeply suffused or quite opaque. Appendages numerous in a rather dense tuft, arising as in other aquatic species; hyaline, short, sparingly branched, constricted at the somewhat suffused septa. Perithecia, $140 \times 50 \mu$. Receptacle, 450μ . Total length, 575μ . Appendages (longest), 45μ . Spores (measured in perithecium) about 50μ .

On *Orectogyrus Bedeli* Reg., Bopora, Liberia, Africa (O. F. Cook).

The several types of this form include but a single mature specimen, so that it is uncertain whether the coloration described or the very abrupt curvature of the perithecium are constant characters. The younger specimens, however, are sufficient to show that the appendages are unlike those of either of the other aquatic Laboulbeniæ. The species is most nearly related to *L. Guerinii*, from which it differs in its more numerous and slender appendages as well as in its general form. With the Madagascar species (*L. Oberthuri*), which occurs on a similar host,

it cannot be by any possibility confused. The five types were found along the margins of the abdomen beyond the tips of the elytra.

LABOULBENIA GUERINII Robin. Plate XXII, fig. 38.

Robin Hist. Nat. d. Veg. Par. p. 64, Plate X, figs. 1-3; Peyritsch Sitz. d. Wien. Acad. Vol. LXVIII, p. 247; Sorokin, Veg. Paras. Vol. II, p. 413, Plate XXXIII, fig. 780; Winter Die Pilze Deutsch. II, p. 921; Berlese Malpighia, Vol. III, p. 54; Saccardo Sylloge Fung. Vol. VIII, p. 910; Thaxter, Proc. Am. Acad. Arts and Sci. Vol. XXVIII, p. 176.

Becoming more or less suffused with smoky brown. Perithecium becoming almost opaque, slightly inflated below, its upper half tapering evenly to the blunt apex, the lip-cells straight, the inner forming a slight prominence. Appendages rather numerous, not equalling the tip of the perithecium, once or twice branched; the lower septa blackened, the intervening cells slightly inflated, the insertion-cell apparently divided into several cells which are opaque and indistinguishable. Receptacle distally rather deeply suffused, the basal and sub-basal cells hyaline or translucent, normal, except that cells IV and V may be distally divided into a few small secondary cells. Perithecia, $110 \times 55 \mu$. Appendages, 55μ . Total length to tip of perithecium, 300μ . Robin's measurements are, — perithecia, $121 \times 45 \mu$; appendages, $30-55 \mu$; total length, 430μ ; greatest breadth, 80μ .

On *Gyretes sericeus* Laboulb., Caracas, Venezuela; on *G. compressus* Lec. (= *G. sinuatus* Lec.) Texas and Illinois.

The North American specimens of this species differ from Robin's account only in their somewhat shorter, stouter habit, which is doubtless due to the fact that they live on a smaller host. The original figures represent slight differences in the appendages, which may well be due to careless reproduction. In other respects the two forms correspond so closely that their identity seems very probable; although more abundant material of both is much to be desired. The species is closely allied to *L. Orectogyri*, as above mentioned, and together with the two preceding and the following species forms a well-marked type within the genus.

The present species occurs, like *L. Guerinii*, along the margins of the elytra of its aquatic host.

LABOULBENIA GYRINIDARUM Thaxter. Plate XXII, figs. 31-37.

Proc. Am. Acad. Arts and Sci. Vol. XXVII, p. 39.

Blackish brown, becoming nearly or quite opaque. Perithecium large, sub-conical or sub-cylindrical, straight, the lip-cells nearly symmetrical, hyaline tipped, each producing a terminal, short, straight, tapering, finger-like, converging outgrowth; often wholly or partly aborted. Appendages hyaline or becoming brownish below, arising in a broad dense tuft from an opaque base, several times irregularly branched, rather closely septate below and constricted at the blackened, often oblique, septa, the cells between which are more or less inflated, the ultimate branchlets slender, hyaline, sub-erect, rarely equalling the tip of the perithecium. Receptacle distally very broad, opaque, abruptly expanded above cell II, cell I usually curved and slender and sometimes elongate. Spores, $90 \times 7-8 \mu$. Perithecia, $190 \times 90 \mu$. Appendages, longer. $100-150 \mu$. Total length to tip of perithecium, average, 375μ ; longer, 480μ ; greatest breadth, 160μ .

On *Gyrinus fraternus* Coup, and several undetermined species, New England; on *G. affinis* Aube, and *G. ventralis* Kirby, Middle States; on *G. analis* Say, Missouri; on *G. confinis* Lec., Oregon; on *G. consobrinus* Lec., and *G. plicifer* Lec., California; on *G. urinator* Illig., France.

This remarkable species is by no means uncommon, and is so peculiar that it could by no chance be confused with any other species. A comparison of its younger stages shows that it corresponds in all essentials to the type structure of the genus, there being primarily a single insertion-cell above cells IV and V, which are normally placed (figs. 32-34), while the appendages are developed originally from an inner and outer basal cell (fig. 34), as in species of the usual type. The outer appendage consists at first merely of two or three roundish superposed cells, terminally more or less bilobed, from which a certain number of branchlets may arise; while the primary basal cell of the inner appendage by constant and successive division and proliferation forms the broad base of insertion characteristic of the mature plant. How far cells IV and V and the insertion-cell take part in forming this base through secondary divisions, the opacity of the plant in this region renders uncertain. Cells I and II are sometimes quite elongate and very slender; but as a rule the general habit is such as is represented in fig. 31. The outgrowths from the lip-cells are similar in a way to those occurring in *Stigmatomyces virescens*. They are often irregular in form and frequently are but partially developed. *L. cornuta* is the only other species of the genus having a somewhat similar outgrowth from one only of its lip-cells.

The trichogyne is highly developed (fig. 36) and peculiarly branched; its terminal branchlets tending to grow sideways in between the bases of the appendages. I have thus far been unable to determine the character of the antheridia in this species, and have even been led to suspect that the antherozoids might be exogenous. It is quite uncertain, however, what their nature really is.

The species occurs along the outer margins of both elytra of its host, sometimes extending to the free tip of the abdomen, often growing in dense tufts. The latter, like all the other aquatic forms infested by members of the present genus, is one which swims on the surface of the water, and is very common in ponds and ditches, or along the margins of streams.

TERATOMYCES Thaxter. Plate X, figs. 1-17; Plate II, fig. 1.

Proc. Am. Acad. Arts and Sci. Vol. XXVIII, p. 182; Vol. XXIX, p. 98.

Receptacle consisting of three superposed cells surmounted by a more or less cup-shaped terminal portion divided by vertical and oblique septa into a series of numerous small cells arranged peripherally, from which arise numerous appendages which completely surround the point of origin of the perithecia. Perithecia one to several (five), symmetrical, with single stalk-cells. Appendages consisting of a short series of sympodial branches, bearing sympodial branchlets directed outward, many terminating in sharply-pointed, beak-like, sterile, terminal cells. Antheridia flask-shaped or beak-like cells, free from one another, superposed in a single vertical external row arising from the lower segments of the appendages. Trichogynes copiously branched and septate. Spores once-septate.

This genus presents one of the most curious and clearly defined types among the Laboulbeniaceæ, and although the succeeding genus *Diplomyces* is evidently its nearest ally, its immediate relations to other genera are very obscure. Owing to the early multiplication of appendiculate cells, the relation of the appendages to the points of origin of the perithecia have not been determined. The exact process by which the terminal series of cells is formed is also not clear. This series does not have the same appearance from all sides, and it appears to be produced as a result of the successive separation of the cells which form it, through the proliferation of the receptacle to the right and left of a common centre within which the perithecia arise. The appendages are unlike those of any other genus, and result from the formation of successive sympodial branches, which are formed in a vertical radial plane. When young they bear the antheridia usually near the base, sometimes alternating irregularly with prominent beak-like branchlets of characteristic appearance, the two forming a single external vertical series (Plate X, figs. 6 and 11). The trichogynes are often very highly developed, varying greatly in their luxuriance in different specimens of the same species. In some cases they are not unlike the appendages in general appearance, the form and mode of branching of their terminal portions being very similar; although in *T. Actobii* there is a very distinct and characteristic modification of the receptive tips of their ultimate branchlets (fig. 17). Fig. 1, Plate II, represents another instance of a highly developed female organ. The perithecia have but four wall-cells in each row, and appear to contain but two ascogenic cells. The species all occur on beetles belonging to the Staphylinidæ, which are found in very wet situations.

TERATOMYCES MIRIFICUS Thaxter. Plate I, fig. 1; Plate X, figs. 4-7.

Proc. Am. Acad. Arts and Sci. Vol. XXVIII, p. 182.

Perithecia one to three, pale, becoming reddish or purplish brown, straight, basally inflated, distally sub-cylindrical; tapering abruptly to a symmetrical truncate apex, the stalk-cell cylindrical, often very elongate. Receptacle somewhat flattened, consisting of a small narrow basal cell, brown but more or less translucent; a larger sub-basal cell, which bulges abruptly on one side and is almost wholly opaque except along this prominence: while the distal of its three cells is hyaline, becoming reddish brown, very variable in length, sometimes much longer than the basal and sub-basal cells together. The larger appendages consist of a single long slender flat reddish-brown basal cell, bearing very numerous antheridia or sterile beak-like branchlets in a single vertical row, the terminal branches larger and themselves one to three times branched, the ultimate branchlets often obliquely septate, the septa dark or terminating in pointed beak-like cells. Spores, $40 \times 4 \mu$. Perithecia, $128-140 \times 22-26 \mu$. Stalk (longest), 480μ . Appendages (longest), 185μ . Receptacle, $110-180 \mu$, greatest width about 45μ . Total length to tip of perithecium, $220-750 \mu$.

On *Acylophorus pronus* Er., Maine and Massachusetts; *A. flavicollis* Sachs., Pennsylvania and Kansas. *A. flavipes* Lec., Florida.

The specimens of this singular species, which were found on the abdomen of *A. flavipes* from Florida, differ from those on the other hosts in their much smaller size, and are not more than half as large as the ordinary form. Yet there seems to be no doubt concerning their identity.

The species is at once distinguished from any of the others by the curious one-sided bulge of the sub-basal cell of its receptacle, which is of course not visible unless the latter lies sidewise. There is great variability in the length and luxuriance of the appendages, which are usually much broken, and in the length of the stalk-cell of the perithecium, which, in mature specimens, is usually several times as long as the perithecium. The third cell of the receptacle is also very variable in length, sometimes decidedly elongate, more commonly short and stout.

The species is usually conspicuous and easily seen at the tip of the abdomen of its host, where it more often occurs in small groups, although it may not infrequently be found on the legs and other portions of the insect. The host *A. pronus* is very common in early summer at the margins of ponds and ditches, hiding in wet moss and rubbish.

TERATOMYCES QUEDIANUS nov. sp. Plate X, fig. 8.

Closely allied to the preceding species. Perithecium larger, sub-cylindrical or very slightly inflated, terminated abruptly by a sub-cylindrical or slightly tapering, bluntly rounded apex. Receptacle elongate, the sub-basal cell long, tapering below and wholly opaque, the blackening involving the base of the cell above it, which is distinctly constricted below the terminal cellular portion. Appendages as in *T. mirificus* much shorter and more thickly beset with brown sharply pointed septate branchlets. Spores, $50-55 \times 4.5 \mu$. Perithecium, $155 \times 30 \mu$. Appendages, longest 150μ . Receptacle, $160-165 \mu$. Total length to tip of perithecium, 450μ .

On *Quedius ferox* Lec., Cambridge, Mass.

Fourteen individuals of this form were found on a specimen of its host collected in April, among leaves in swampy woods about Fresh Pond. The species, though very close to *T. mirificus*, seems constant in its differences, and is easily distinguished by the structure of its receptacle, which lacks the prominence peculiar to the last-mentioned species, as well as by the different form of the tip of its perithecium. But two of the specimens are fully mature, and more abundant material would doubtless show much greater range in size than is indicated by the measurements given above.

TERATOMYCES ACTOBII Thaxter. Plate X, figs. 9-17.

Proc. Am. Acad. Arts and Sci. Vol. XXIX, p. 98.

Perithecia one to four, reddish brown, distinctly inflated towards the base, the distal portion symmetrically conical, tapering to a blunt apex; borne on a single short stalk-cell not exceeding the appendages in length, followed by three rather large basal cells disposed as in *T. mirificus*. Receptacle short, nearly symmetrical, tinged with brownish or nearly hyaline, consisting of three superposed cells, the basal small and narrow, the sub-basal squarish, sometimes partly or wholly opaque, the distal large, rounded, and followed by the series of small cells from which arise the numerous appendages which in general resemble those of *T. mirificus*, though proportionately stouter and more intricately branched. Spores, $26 \times 3.7 \mu$. Perithecia, $120-137 \times 37 \mu$. Stalk-cells, $75-100 \mu$. Longest appendages, 150μ . Three basal cells of receptacle, $37 \times 22 \mu$.

On *Actobius nanus* Horn., Kittery Point, Maine; Arlington, Mass.

This species occurs with the next on the legs of its host, less frequently on the thorax or abdomen. It differs from *T. mirificus* in the form of its perithecia, which are sub-conical, as well as by its symmetrical receptacle. The short stalk-cell and large basal cells of its perithecia serve also to distinguish it.

TERATOMYCES BREVICAULIS Thaxter. Plate X, figs. 1-3.

Proc. Am. Acad. Arts and Sci. Vol. XXIX, p. 99.

Perithecia one to five, purplish brown, long, slender, straight or slightly curved, cylindrical or slightly inflated near the middle, tapering abruptly to the almost truncate apex, much longer than the stalk and basal cells together, the latter concolorous with the perithecium, the stalk-cell nearly hyaline. Receptacle nearly symmetrical, black and quite opaque, except the partly translucent basal cell; above the opaque portion expanding abruptly to form the broad distal portion, from the numerous small cells of which arise, around the edge, the circle of crowded appendages which surround the perithecia. Larger appendages faintly tinged with brownish purple, consisting of a rather short stout basal cell bearing below, externally, several antheridia and short simple pointed branchlets, above one to several large branches, which in turn branch near their distal ends one to three times successively in the same plane, the basal cells of the branches and primary branchlets usually distally inflated, the ultimate branchlets obliquely septate and blunt, or more often ending in a sharply pointed cell. Spores, $33 \times 4 \mu$. Perithecia, $110-120 \times 23 \mu$. Stalk-cells, $50 \times 15 \mu$. Receptacle, $85 \times 50 \mu$. Longest appendages, 100μ .

On *Actobius nanus* Horn, Kittery Point, Maine, and vicinity of Cambridge, Mass.

This species is much rarer than the preceding, which is sometimes associated with it on the abdomen of its host. It is subject to considerable variation in size and in the length of its appendages, but is always readily distinguished by the form of its short-stalked perithecia and the peculiar more or less clavate form of the larger cells of its appendages. The host occurs with *Acylophorus pronus*, but is less common.

DIPLOMYCES Thaxter. Plate X, figs. 18-21.

Proc. Am. Acad. Arts and Sci. Vol. XXX, p. 468.

Flattened antero-posteriorly, sub-triangular, bilaterally symmetrical, furcate through the presence of a pair of prominent posterior projections. The receptacle consisting of two superposed cells, followed by four cells placed antero-posteriorly in pairs, of which the posterior produce the characteristic prominences; the anterior a pair of short stalked perithecia, near the base of which, within and above, arise two or more pairs of appendages, and eventually a second pair of perithecia. Appendages copiously branched, many of the branchlets terminated by beak-like cells. Spores once-septate.

A singular genus, recalling *Teratomyces*, to which it seems most nearly allied through the presence of the characteristic terminal beak-like cells of its appendages. The branching of the latter is not, however, sympodial in a single plane, as is the case in *Teratomyces*, and the general structure of the receptacle is difficult to homologize with that of any other genus. The

second pair of perithecia arise in all probability from secondary divisions of the pair of perithecia-bearing cells above described; but the exact structure in this region, behind the stalk-cells of the perithecia, has not been made out satisfactorily. An obliquity in the septum which separates the basal and sub-basal cells sometimes results in the apparent absence of any sub-basal cell.

DIPLOMYCES ACTOBIANUS Thaxter. Plate X, figs. 18-21.

Proc. Am. Acad. Arts and Sci. Vol. XXX, p. 469.

More or less faintly tinged with brownish. Basal cell of receptacle triangular, sub-basal cell flattened or wedge-shaped; the posterior prominences peculiar to the genus nearly as long as the receptacle itself, slightly divergent, two-celled, the terminal cell twice as long as the basal, tapering slightly towards its rounded extremity. On the anterior side the two perithecial cells bear the first pair of perithecia on short stalk-cells bent abruptly upward, divergent, and succeeded by three small cells forming the base of the perithecium. The perithecia rather slender, curved towards the receptacle, so that their tips project beyond it, divergent, rather long and slender, tapering slightly, the apex blunt with ill defined lips, the base of the old trichogyne persisting conspicuously below the pore. Appendages branching, arranged in pairs symmetrically like the perithecia; a smaller one arising just behind the stalk-cell of the perithecium, a much larger one above this followed by a few smaller ones less definitely arranged in the region whence a second pair of perithecia may arise. All the appendages more or less copiously branched, the branchlets terminating in many cases by the slender, curved, and sharply pointed cells characteristic of Teratomyces. Spores, $32 \times 2 \mu$. Perithecia, including stalks, about $75 \times 12 \mu$. Receptacle to tips of prominences, 75μ . Total length to tip of perithecia, 110μ . Greatest width, 37μ .

On *Actobius nanus* Horn, Massachusetts.

This species occurs rather rarely on the abdomen of a large brown variety of *Actobius nanus*, but not as far as has been observed on the normal form. A second species, perhaps distinct from the present, was found on the abdomen of a small *Philonthus*, and is distinguished by the presence of slender thread-like branches from the larger appendages. Sufficient material of this form was not, however, obtained, and it may prove to be nothing more than a variety of the one above described.

RHACHOMYCES Thaxter. Plates II, IV, X-XII.

Proc. Am. Acad. Arts and Sci. Vol. XXX, p. 468; *Acanthomyces* Thaxter (nec Lebert), l. c. Vol. XXVII, p. 36.

Receptacle consisting of a single basal cell surmounted by a more or less elongated body composed on one side of a primary series of superposed nearly equal cells; on the opposite side of a second series, of smaller and more numerous cells bearing large numbers of bristle-like appendages, extending up to and more or less surrounding the base of the perithecium. Perithecia produced laterally near the tip of the receptacle, at maturity apparently terminal, stalked or nearly sessile, symmetrical. Spores once-septate. Antheridial cells single, terminal on short stalks.

This well-defined and characteristic genus was first described by me under the name *Acanthomyces*, in ignorance of the fact that it had already been used by Lebert in a zoological paper (*Zeitschrift für Wissenschaftliche Zoologie*, 1858, Vol. IX., p. 447) for an entomogenous fungus probably identical with *Isaria sphingum*. The name *Rhachomyces* has been substituted as suggesting the resemblance which the main axis of the plant bears to a vertebral column, a resemblance sometimes made more striking by the presence of a sigmoid curve (Plate XII, fig. 6).

The eight species which compose the genus are very constant in their essential characters, and vary chiefly as regards the number of cells composing the main axis of the receptacle, and in the number and length of the appendages. Extremes in these respects are represented by the two species *R. pilosellus* (Plate XII, figs. 12-13) and *R. longissimus* (fig. 4). I have been unable to obtain a series of young specimens to illustrate the complete development of the main axis of the receptacle; but from the specimens available it is evident that the main body of the latter arises as a lateral outgrowth, somewhat in the same manner and in the same position that the perithecium of genera like *Laboulbenia* or *Stigmatomyces* originates. The youngest condition observed consists of a simple series of superposed cells, the terminal portion of which, all above the sub-basal cell, becoming blackened and modified to form the lowest member of the series of appendages, which are characteristic of all the species of this genus. It is then as an outgrowth from the sub-basal cell that all the remainder of the plant is developed. The first indication of this development is seen in fig. 10, Plate XII, in which an oblique partition has divided the sub-basal cell into an upper and a lower portion, and it is from the subsequent divisions of this upper portion that the body of the receptacle, including the male and female organs, arises. The axis, as in so many other instances among the Laboulbeniaceæ, more especially in the case of their appendages, seems to consist in reality of a series of sympodial branches, while the appendages and antheridial branchlets arise from small cells, which become laterally separated on one side. The appendages are arranged in two vertical rows throughout the greater portion of the axis, thus succeeding one another in pairs as a rule; and between them and for the most part wholly concealed by them are borne sterile or antheridial branchlets; the latter, so far as known, also produced in pairs, appressed in habit, each bearing a single terminal, flask-shaped antheridium of the usual form (figs. 18-19). The perithecium seems to arise from one of the sub-terminal cells of the main axis between the appendages, which may at maturity be present around its base. The terminal portion of the axis often extends normally some distance beyond the base of the perithecium, as in *R. furcatus*; while in other cases it may be very short, as in *R. lasiophorus*; and it is from this portion that the proliferation described below takes place.

The receptacle normally bears but a single perithecium, but in exceptional cases two may be formed side by side from the same cell (Plate X, fig. 22). When, however, the trichogyne has for any reason failed to become fertilized, or the perithecium which was first formed is injured or becomes infertile, a terminal proliferation of the axis takes place, and from this proliferation is produced sub-terminally a second perithecium, as in fig. 2, Plate XII. This process may be once or even twice repeated, as in fig. 14; but in any case the phenomenon is not to be considered a normal occurrence. It may be mentioned as a curious fact that the number of cells which compose one of these proliferations in a given species seems to be more or less constant, as indicated in the figure last cited.

The perithecium is but slightly flattened, its cell-rows composed of four cells, and contains four ascogenic cells at maturity. The trichogyne, which has been observed in a few instances, is rather short and sparingly branched and septate (Plate II, fig. 6). The sterile appendages are very characteristic in appearance, being invariably simple, usually quite opaque, except along their upper margin, and more or less distinctly septate.

The species occur on beetles belonging to the Carabidæ and Staphylinidæ, two of them on cave beetles, and are found in Europe, Africa, and North America, including Mexico.

RHACHOMYCES LASIOPHORUS Thaxter. Plate II, fig. 6; Plate XII, figs. 7-11 and 17-19.

Proc. Am. Acad. Arts and Sci. Vol. XXX, p. 467; *Acanthomyces lasiophorus* Thaxter l. c. Vol. XXVII, p. 37.

More or less suffused with blackish brown. Perithecium sessile, becoming brown, somewhat inflated, nearly symmetrical, tapering to a rather blunt apex. Appendages arranged in two rows of larger bristle-like members, hyaline-tipped, blackish below, running from the sub-basal cell to the apex of the receptacle, where they surround the base of the perithecium, which exceeds them by about half or one-third its length: from the cells of the receptacle between these two rows arise smaller appendages, which become more numerous towards its extremity. Receptacle slender at the base, expanding upward, consisting of a main axis of about twelve superposed vertebra-like cells, at first hyaline, becoming blackish, and of a series of smaller cells almost completely concealed by the appendages. Spores, $30 \times 3 \mu$. Perithecia, $140-145 \times 50 \mu$. Larger appendages, $75-90 \mu$. Receptacle, 175μ .

On *Atranus pubescens* Dej. New Hartford, Connecticut; Stony Brook, Mass.; Virginia. On *Badister micans* Lec., *Acupalpus carus* Lec., and *gen. indet.*, Kittery Point, Maine.

A few specimens of a species apparently identical with this were found on a small species of *Platynus* captured in swampy woods at Kittery, but these as well as the host have been unluckily lost. The usual host of the species is quite rare, and I have found but four specimens, two of which were infested. The Virginia specimens were collected near Washington by Mr. Pergande. The compact form, brown inflated perithecium, short, stout, and closely appressed appendages serve to distinguish the species from its allies.

Within the past year further material of this form has been collected at Kittery on the two additional hosts above mentioned, from which it is apparent that the species is subject to considerable variations in size and form. Figures 17-19 of Plate XII were drawn from this material, and fig. 17 represents the greatest divergence from the type observed in any of the mature individuals.

RHACHOMYCES SPELUNCALIS Thaxter. Plate XI, figs. 23-25.

Proc. Am. Acad. Arts and Sci. Vol. XXX, p. 468.

Perithecium more or less deeply suffused with brown; short and stout, with a broad, bluntly rounded apex. Receptacle slender, the main axis constricted strongly at the septa, its cells rather small, the basal slender and cylindrical; the remainder, about nine in number, all evenly and rather deeply suffused with brown, and more or less uniform in size. Appendages mostly

opaque, more or less rigid, hyaline-tipped, those surrounding the base of the perithecium hardly equalling it in length, a few lower on the receptacle exceeding its apex by the whole length of the plant; of the shorter median appendages some are terminated by a peculiarly modified, partly hyaline antheridial cell, the neck-like tip of which curves strongly outward, terminating bluntly. Perithecia, $90 \times 37 \mu$. Receptacle about 110μ (when not proliferous). Longest appendages, 300μ . Total length to tip of perithecium, 185μ to 260μ (in proliferous forms).

On *Anophthalmus pusio* Horn, West Virginia.

The smallest species of the genus, more nearly allied to *R. lasiophorus* in the form of its perithecium and the disposition of its appendages around the base of the latter, but differing in its slender form, longer and more slender appendages and irregularly constricted receptacle. A small number of specimens were found growing near the tips of the elytra of its host, a blind cave beetle. The curved cells borne on short branches (fig. 25) are conspicuous in some specimens, and are undoubtedly antheridia.

RHACHOMYCES LONGISSIMUS Thaxter. Plate XII, fig. 4-5.

Proc. Am. Acad. Arts and Sci. Vol. XXX, p. 467; *Acanthomyces longissimus* Thaxter l. c. Vol. XXVIII, p. 176.

Perithecium brown, darker at the blunt apex, slightly inflated, its two lower thirds almost completely surrounded by a series of appendages arising from its base. Receptacle very long and slender, slightly flexuous, its main axis consisting of about thirty superposed cells deeply suffused with blackish brown, lighter at the septa. Appendages very numerous, externally opaque, internally more or less hyaline, short, slender, straight, appressed; a few curved, projecting outward on either side in successive pairs. Spores, $60 \times 4 \mu$. Perithecia, $185 \times 55 \mu$. Appendages about 110μ long, those at the base of the perithecium about 165μ . Receptacle slightly exceeding a millimeter in length by 30μ broad.

On *Colpodes evanescens* Bates, Guatemala.

One of the largest of all the Laboulbeniaceæ found on the elytra of a small Colpodes in the collection of the Museum at Cambridge. Apart from its great size it is readily distinguished by the curious disposition in pairs of certain of its slender appendages.

RHACHOMYCES HYPOGÆUS Thaxter. Plate XII, fig. 6.

Proc. Am. Acad. Arts and Sci. Vol. XXX, p. 467. *Acanthomyces hypogæus* Thaxter l. c. Vol. XXVIII, p. 177.

Perithecium nearly sessile, terminal, pale straw-colored, hardly inflated, continuing the sigmoid curve of the receptacle, its blunt apex exceeding the tips of the appendages by about half its length. Receptacle uniformly pale straw-colored, bent in a sigmoid curve, the base slender, the remaining portion stout, the main axis consisting of about eighteen superposed cells with very oblique septa, the appendiculate cells unusually large, their bases externally distinct. Appendages numerous, closely set, appressed, slightly curved inward, deep brown, the tips paler. Perithecium, $145 \times 37 \mu$. Appendages, $110-150 \mu$. Receptacle, $340 \times 37 \mu$.

On *Anophthalmus Bilimeki* Sturm., Carniola, Austria.

One mature and several immature specimens of this fine species were found on the elytra of a specimen of its host in the collection of the Cambridge Museum. It is at once distinguished by its sigmoid outline, colorless receptacle, and appressed, incurved, short appendages, as well as by the unusual development of its appendiculate cells.

RHACHOMYCES ARBUSCULUS nov. sp. Plate IV, figs. 6-7.

Perithecium pale straw-colored, long and slender, tapering slightly and gradually towards the bluntly rounded apex, which is suffused with brown; the stalk-cell short, for the most part hidden by the appendages. Receptacle slender, curved or slightly sigmoid; the cells of the main axis, about twenty to twenty-five in number, more or less deeply suffused with blackish brown; the septa rather oblique; the apex distinct beyond the insertion of the stalk-cell of the perithecium. Appendages numerous, externally black and opaque, the inner margin more or less transparent, stiff, short, their tips more or less prominently and abruptly recurved, arising from all except the basal cell of the receptacle, and projecting obliquely upward; those at the base of the perithecium somewhat longer and more prominently curved away from its base on either side. Perithecium, $170-190 \times 35-38 \mu$. Spores about 50μ long (measured in the perithecium). Receptacle, $200-325 \mu$ long. Appendages, $85-100 \mu$.

On an undetermined staphylinid allied to *Lathrobium*, Mt. Coffee, Liberia, Africa (O. F. Cook).

This species corresponds in all respects to the type so closely adhered to in all the other species of this genus, from which it may be readily distinguished by its long slender form and very numerous short recurved appendages. The types, which are in excellent condition, were found on the abdomen of the host, a small riparian staphylinid.

RHACHOMYCES FURCATUS Thaxter. Plate XII, figs. 1-3.

Proc. Am. Acad. Arts and Sci. Vol. XXX, p. 467; *Acanthomyces furcatus* Thaxter l. c. Vol. XXVIII, p. 177.

Perithecium more or less suffused with brownish, straight, slightly inflated at the base, tapering gradually to the apex, borne on a stout and well marked stalk-cell. Receptacle more or less tinged with brownish, its main axis consisting of about twelve superposed cells, continued by a more slender prolongation beyond the base of the perithecium, this prolongation sometimes forming a second successive main axis terminated by a second perithecium and continued by a similar prolongation beyond the base of this second perithecium, which arises on the side of the general axis nearly opposite to that which bears the first. Appendages dark brown, opaque, stout, rigid, nearly straight or slightly curved outward, the longest not equalling the tip of the perithecium. Spores, $48 \times 4 \mu$. Perithecia, $160-185 \times 48-55 \mu$. Appendages (longest) about 150μ . Total length to tip of receptacle about 360μ . Main body of receptacle about 220μ long. Total length when two perithecia present (longest), $550-600 \mu$.

On *Othius fulvipennis* Fab., Germany.

A number of specimens of this large and well-marked species were found on the abdomen of a specimen of its host in the collection of the Museum at Cambridge. It is characterized by

the conspicuous prolongation of its receptacle beyond the base of the perithecium, which gives it a more or less furcate habit. The perithecium is large and its stalk-cell more highly developed than that of any other species.

RHACHOMYCES LATHROBII Thaxter. Plate X, figs. 22-23.

Proc. Am. Acad. Arts and Sci. Vol. XXX, p. 467; *Acanthomyces Lathrobii* Thaxter l. c. Vol. XXVIII, p. 178.

Perithecium becoming slightly suffused with brown, its blunt conical tip dark brown, contrasting; rather slender, slightly inflated towards the base, borne on a short stalk-cell more or less concealed. Receptacle consisting usually of eight to ten superposed cells, forming the main axis and deeply suffused with blackish brown except at the nearly hyaline septa. Appendages large, curved, almost opaque, nearly equalling, often greatly exceeding, the tip of the perithecium. Spores about $50 \times 4 \mu$. Perithecia, $100-130 \times 35-40 \mu$. Appendages (longer), $150-450 \mu$. Receptacle (average), 110μ long.

On abdomen of *Lathrobium longiusculum* Grav., New Hampshire and Lake Superior; *Lathrobium* sp., Pennsylvania.

The appendages of the specimens from New Hampshire are constantly far longer than those of the Lake Superior specimens, resembling *A. pilosellus* in this respect. The two forms seem otherwise identical, and are distinguished from *A. pilosellus* by the characteristically brown-tipped perithecium, longer receptacle, and more densely crowded appendages. The infested hosts were all found in the collection of the Museum at Cambridge.

RHACHOMYCES PILOSELLUS Thaxter. Plate XII, figs. 12-15.

Proc. Am. Acad. Arts and Sci. Vol. XXX, p. 467; *Laboulbenia pilosella* Robin, *Traité du Microscope*, p. 912, fig. 285 (1871); *Acanthomyces brevipes* Thaxter, Proc. Am. Acad. Arts and Sci. Vol. XXVIII, p. 177.

Perithecium suffused with reddish brown, subfusiform with a distinct stout stalk-cell. Receptacle very short, the main axis consisting usually of five superposed cells, with a short prolongation beyond the base of the perithecium, normally of not more than three or four cells, the cells all pale yellowish or with brown suffusions, the septa in all cases usually hyaline. Appendages few in number, opaque or nearly so, scattered, some of them very long, curved, and greatly exceeding the tip of the receptacle. Spores, $55 \times 4 \mu$. Perithecium, $150-165 \times 45-55 \mu$. Receptacle, main body about $75 \times 30 \mu$, its prolongation about $35-40 \mu$. Stalk of perithecium about $40 \times 30 \mu$. Appendages (longest), $375-500 \mu$.

On *Lathrobium fulvipenne* Grav., Germany.

This small species is distinguished from its near ally *R. Lathrobii*, by its shorter and differently shaped receptacle, concolorous perithecium, and scattered appendages. The specimens examined were obtained from material of its host in the collection of the Museum at Cambridge labelled "Germany," and were found growing on the insect's abdomen. I have been unable to discover any diagnosis of this species in Robin's "Traité" beyond the description of the plate, and was unaware that no description existed when I referred my own species to this form in the paper cited above. Although the name *R. brevipes* might very properly be retained, in view of

the lack of any proper description, it seems superfluous to complicate the synonymy further, and it must be confessed that Robin's figures, with their description, constitute quite as satisfactory a basis for determination as is afforded in the case of many other species.

CHÆTOMYCES Thaxter. Plate XI, figs. 20-22.

Proc. Am. Acad. Arts and Sci. Vol. XXVIII, p. 178.

Receptacle consisting of a slender rigid series of superposed cells from which arise successively in a unilateral series the appendages, and one, rarely two, perithecia. Perithecium flattened stalked. Appendages one from each cell, simple or branched, produced one or more below the origin of the perithecium, the rest above it. Spores once-septate.

This well-marked type differs from other genera, from the fact that as many as three of the cells of the receptacle lying below the origin of the perithecia may give rise to appendages apparently fertile. The lowest of the latter which form the series above the perithecium, also seem to be fertile, producing a small number (one or two) of rather slender flask-shaped cells; but no discharge of antherozoids has been observed from them. The cells immediately above the origin of the perithecia bear no appendages, but the lowest sometimes produces a second perithecium. The perithecium appears to have four cells in each series of wall-cells, but it has not been possible to determine this beyond question.

CHÆTOMYCES PINOPHILI Thaxter. Plate XI, figs. 20-22.

Proc. Am. Acad. Arts and Sci. Vol. XXVIII, p. 179.

Perithecium suffused with purplish, more deeply at the base and along its inner half, long, slender; the inner margin nearly straight, the outer curving inward, distally to the prominent somewhat angularly inflated tip; the stalk-cells bent upward at the base, so that the axis of the perithecium is nearly parallel to that of the receptacle, the lower short and narrow, the upper becoming distally as broad as the perithecium, the basal cells of which are not distinguished from it and are similarly suffused with purplish. Receptacle bristle-like, composed of about fourteen superposed sub-cylindrical or somewhat flattened cells, almost or quite opaque and indistinguishable, the series usually bent backward at the base and, more abruptly, at the apex. Of these cells the three (rarely four) basal ones bear no appendages; above these one to three cells may bear fertile appendages, and are in turn succeeded by one, rarely two cells, from which are produced single perithecia; above these follow two to four cells without appendages, while the series is completed by five or six distal cells bearing short stout sparingly branched tapering hyaline, mostly sterile appendages. Fertile appendages hyaline, sparingly branched, the antheridia irregularly placed. Spores very slender and sharply pointed, $37 \times 1.5-2 \mu$. Perithecia (including basal cells) $90-130 \times 22 \mu$; stalk-cells about 30μ long by $18.5-22 \mu$ distally, 11μ wide at base. Total length of receptacle $150-165 \times 7.5-8 \mu$. Appendages (longer) about $50-60 \mu$.

On *Pinophilus latipes* Er., Southern States.

A specimen of this host bearing the parasite in considerable numbers on the under side of its abdomen was found in the Leconte collection of Coleoptera. The fungus under a hand lens looks like a stiff slender bristle, and might readily be overlooked even when present in considerable numbers. The material, though abundant, contained no very young individuals, so that the early development is unknown.

SPHALEROMYCES Thaxter. Plates III and XI.

Proc. Am. Acad. Arts and Sci. Vol. XXIX, p. 95.

Receptacle consisting of two superposed cells, the upper bearing the appendage laterally, and the stalk-cell of the perithecium terminally. Perithecium asymmetrical, each series of wall-cells composed of five cells; the apex somewhat pointed, the stalk-cell free. Appendage consisting of a basal cell bearing a series of superposed cells, each of which gives rise from its inner upper angle to a single short septate simple antheridial branch. Spores once-septate. Ascogenic cell solitary.

This somewhat insignificant genus is perhaps related to *Compsomyces*, as may be indicated by the structure of its perithecium, the wall-cells of which are unusually numerous. The peculiar disposition of the canal cells near the tip has been already referred to (p. 231). The trichogyne has been observed in a single specimen only, which was badly broken. It appears to be filamentous and branched. Owing to its rarity the early stages have not been observed. In a single young specimen of *S. Lathrobii* (Plate XI, fig. 19) a perfect appendage was obtained, showing the sub-terminal origin of the flask-shaped antheridia, and the presence of a peculiar spine at the base of the sub-terminal cell, to which reference has been made above (p. 209). Although marked by no great peculiarities, the generic type is clearly defined by the two very distinct species.

SPHALEROMYCES LATHROBII, Thaxter. Plate XI, figs. 2-5, 19; Plate III, figs. 1-2.

Proc. Am. Acad. Arts and Sci. Vol. XXIX, p. 95.

Wholly hyaline or faintly yellowish. Perithecium rather slender, slightly inflated toward the base, tapering to the somewhat pointed apex which is bent inward; the dividing lines between the wall-cells indicated by successive ridges, the distal more prominent; the stalk-cell short, the basal cells rather large. Receptacle consisting of two obliquely superposed cells, the upper bearing the stalk-cell of the perithecium distally and the basal cell of the appendage laterally. Appendage borne on a large basal cell connected on its inner side with the distal cell of the receptacle and a portion of the stalk-cell of the perithecium, its exterior wall usually much thickened so as to form a more or less distinct rounded prominence at the base of the appendage proper, which consists of a series of four or five obliquely superposed cells diminishing in size towards its apex, from each of which arises on the inner side a single branch; the branches directed obliquely upward and forming a single series, septate, cylindrical, simple or bearing near their tips single short flask-shaped antheridia. Spores, $35 \times 3-3.5 \mu$. Perithecia, $100 \times 22 \mu$ – $140 \times 36 \mu$. Total length to tip of perithecium, 160–240 μ . Total length to tip of distal branch of appendage, 110–166 μ . Receptacle, 38–45 μ long.

On *Lathrobium nitidulum* Lec. and *L. punctulatum* Lec., Kittery Point, Maine; on *Lathrobium* spp. indet. Arlington, Mass., Lake Superior.

This species seems to be a rare one, and inhabits the legs and abdomen of its host, where, owing to its small size and pale color, it is detected with difficulty. Specimens on *L. nitidulum* are distinctly smaller than those on the second host, but otherwise there seems to be little variation in the rather insufficient material examined.

SPHALEROMYCES OCCIDENTALIS, Thaxter. Plate XI, fig. 1.

Proc. Am. Acad. Arts and Sci. Vol. XXX, p. 469.

More or less evenly tinged with brownish. Perithecium large, subfusiform, with faintly defined ridges at the divisions between the wall-cells, the apex made externally oblique through the outgrowth of one of the lip-cells, which forms a pointed projection beyond the pore; the stalk-cell wholly free, tapering to a narrow base, and about as long as the receptacle proper. Receptacle small, pointed below, its sub-basal cell united throughout its length to the basal cell of the appendage, its basal and sub-basal cells separated by a horizontal septum. The appendage straight, rigid, tapering, composed of a series of usually four superposed cells separated by oblique partitions, and bearing short branches with flask-shaped antheridia from their upper inner angles. Perithecia, $200 \times 45 \mu$. Length to tip of perithecia, 350μ . Length to tip of appendage, 200μ . Length of receptacle, 55μ .

On *Pinophilus densus* Lec., Utah.

The present form was found on the abdomen of its host, and is readily distinguished from *S. Lathrobii* by the peculiarly modified tip of its perithecium, as well as by other important differences. The scanty material examined was obtained from specimens of the host (a staphylinid beetle living under bark(?)) contained in the Le Conte collection.

COMPSOMYCES Thaxter. Plate XI.

Proc. Am. Acad. Arts and Sci. Vol. XXIX, p. 96; *Cantharomyces* Thaxter pro parte, l. c. Vol. XXIV, p. 9.

Receptacle consisting of two superposed cells, the distal bearing from its extremity several appendages and one, rarely two, stalked perithecia. Appendages sterile or fertile, simple or branched, septate; the fertile ones bearing one or more single one-celled antheridia, sessile at the extremities of the successive cells, which form the main axis of the appendage. Perithecium symmetrical, conical, borne on two superposed stalk-cells, the lower of which bears one, rarely two, terminal simple appendages. Asci eight-spored. Spores once-septate. Trichogyne copiously branched, the receptive tips coiled in a close spiral.

This genus, though closely related to and possibly identical with *Moschomyces*, has no other near allies, unless it be *Sphaleromyces*, and its position in the series is very doubtful. With the two exceptions mentioned, it differs from other genera with endogenous antherozoids in having five cells in each series of perithecial wall-cells. *Moschomyces* also is the only other instance in which the peculiar appendiculate basal stalk-cell characteristic of this genus is found. The trichogyne when well developed, as in fig. 9, is the most remarkable structure of its kind in

the whole family, its spiral terminations being invariably present and of very regular form. It is possible that the lower stalk-cell of the perithecium is morphologically a part of the receptacle and not homologous with the ordinary stalk-cells. Its early derivation, however, has not been determined.

COMPSOMYCES VERTICILLATUS Thaxter. Plate XI, figs. 6-15.

Proc. Am. Acad. Arts and Sci. Vol. XXIX, p. 97; *Cantharomyces verticillatus* Thaxter l. c. Vol. XXIV, p. 9.

Nearly hyaline, becoming pale straw-yellow. Perithecium, very rarely more than one, not distinguished from its basal cells, inflated below, its slender, terminal portion tapering gradually to the blunt symmetrical apex, the eight basal and sub-basal wall-cells producing a corresponding number of more or less conspicuous prominences. Receptacle two-celled, the basal cell sometimes furnished with a partly blackened outgrowth from its base. Appendages two or three to eight or more, arising sub-verticillately from the sub-basal cell, simple or sparingly branched, the cells short and usually distally expanded. Spores, $20-22 \times 3 \mu$. Perithecia, $90-150 \times 20-35 \mu$; its two stalk-cells (longest), 185μ . Receptacle, $18-80 \mu$. Total length to tip of perithecium, $140-400 \mu$.

On *Sunius longiusculus* Mann., Anna, Illinois and Kittery Point, Maine.

This graceful form was first received from Prof. S. A. Forbes, who kindly sent me two mounted specimens from Illinois, on which the original description was based. These specimens, however, were so imperfect that its really essential characters (the form and position of the antheridia) were not made out. Its general structure, however, seemed so like that of *Cantharomyces Bledii*, received at the same time from the same source, that the two were united under a common generic name. Later, more abundant material of *C. Bledii* and the discovery of two additional species offered an opportunity for a more exact characterization of the genus *Cantharomyces* on a basis of these three species, the *C. verticillatus* of my first paper being still in doubt until an abundance of material was obtained at Kittery.

The species varies very considerably in size according to its position on the host, specimens on the elytra and near the tips of the legs being often very small. The length of the receptacle also varies very considerably, and the hoof-like modification of the foot (fig. 13), which finds a parallel only in *Laboulbenia Philonthi* (Plate XXII, fig. 28) sometimes occurs. The rounded projections from the lower cells of the perithecial wall (fig. 11), are also very variable in form and are often hardly apparent. In very rare cases the lower stalk-cell of the perithecium may bear two appendages from its distal end, which though almost invariably simple, may sometimes produce short branches. Two perithecia (fig. 8) have been observed in only two instances. The antheridia (fig. 14) are produced in small numbers, one or two from the distal ends of some of the lower cells of the appendages.

The hosts are common in dry rubbish in cultivated fields.

MOSCHOMYCES Thaxter. Plate XI, figs. 16-18 and 26.

Proc. Am. Acad. Arts and Sci. Vol. XXIX, p. 97.

Receptacle composed of a sucker-like compacted mass of parenchymatous cells penetrating the softer chitin of the host and giving rise above to numerous free cells from the distal ends of which are produced solitary stalked perithecia and appendages. Perithecium very large, sub-conical, pointed, the apex symmetrical, borne on two simple superposed stalk-cells followed by three small basal cells; the basal stalk-cell bearing from its distal end a single simple sterile appendage. Appendages septate, sparingly branched or simple, the fertile ones stouter, bearing the antheridia on short branchlets. Asci sub-cylindrical, eight-spored, arising in great numbers and in many rows from a single ascogenic cell. Spores minute, once-septate.

This genus, although at first sight so remarkably distinguished from all others by its habit of penetrating its host and by a cellular base, may yet prove merely a well-marked species of the preceding genus. This suggestion is made on the supposition that an "individual" such as is represented by fig. 16 is in reality an aggregation of as many individuals as there are cells in its penetrating base. The spores are discharged in enormous numbers from the perithecium, and show a marked tendency to adhere in masses (fig. 18). It is a question, therefore, whether the "individual" as figured does not represent the product of one of these masses and not the product of a single spore. Apart from this apparently compound habit, the essential characters of the genus are very similar to those of *Compsomyces*. If this supposition is correct, the sucker-like base is morphologically a compound foot, while the "numerous free cells" above described as rising from it represent the sub-basal cells of the true receptacle. Whether the latter has a basal cell distinct from the intruded cells cannot be seen in the specimens examined.

The antheridia are flask-shaped cells borne at the tips of short branches, which arise near the ends of the stouter appendages (fig. 26), and are unlike those of *Compsomyces*. In one specimen, unfortunately destroyed, several trichogynes were observed, which though not as luxuriant as is often the case in *Compsomyces*, were terminated by the same regularly coiled spiral branchlets. As far as can be determined, the asci arise from a single ascogenic centre, apparently a single large cell, but possibly a coherent group of cells. The asci (fig. 17) are sub-cylindrical, with a long, slender pedicel (partly broken in the figure), eight-spored and produced in very great numbers. The ascus mass is a most remarkable object when viewed in fresh material under the microscope. What may be called the dorsal view of this mass (represented in the second perithecium from the right in fig. 16) shows with great distinctness the round ends of a multitude of asci with their contained spores, projecting towards the observer and gradually losing themselves above in the mass of spores, which must be counted in a single perithecium almost by thousands. The structure of the perithecium is, like that of *Compsomyces*, unusual, there being five transverse series of wall-cells, the lower four marked by singular ridges.

MOSCHOMYCES INSIGNIS Thaxter. Plate XI, figs. 16-19.

Proc. Am. Acad. Arts and Sci. Vol. XXIX, p. 97.

Perithecium pale straw-colored, becoming tinged with brown, the lower portion slightly inflated and abruptly contracted at the base, the distal portion sub-conical, sometimes slightly bent to one side, the apex narrow, truncate, symmetrical, the surface marked by two series of ridges extending around the perithecium, each series composed of four distinct and prominent ridges placed somewhat irregularly and indicating the lines of separation between the middle and the upper and lower series of cells which form the walls of the main body of the perithecium; basal cells of the perithecium small, four in number, not distinguished from it, but somewhat abruptly distinguished from the distal stalk-cell, which is long, sub-cylindrical, sometimes inflated and curved; the basal stalk-cell usually shorter and smaller, bearing distally a single slender, simple, rather closely septate, tapering appendage, usually about as long as the distal stalk-cell. The appendages, which together with the single stalked perithecium spring in groups of three or four from the distal ends of large cylindrical cells projecting from the sucker-like receptacle (more rarely arising from the latter directly), are simple or once branched, either sterile or producing the solitary antheridia on short branches near their extremities. Spores very minute, acicular, septate near the middle, $12 \times 3 \mu$. Asci sub-cylindrical, $40-45 \times 7.5 \mu$, eight-spored, the spores sub-distichous. Perithecia, $225-290 \times 55-75 \mu$, the stalk-cells (longest), 425μ , average, $375-25 \mu$. Appendages, $175-375 \mu$ long. Breadth of sucker-like receptacle, 75μ .

On *Sunius prolixus* Er., Waverly, Mass.

This form, which is among the most remarkable in the whole group, inhabits only the softer chitinous membranes of its host, beneath the elytra and at the bases of the legs or between the segments, which it perforates by the intrusion of its sucker-like base. From its large size it is readily seen, and when growing from the base of its host's legs projects upward, sometimes on both sides of the thorax, so that the whole or part of the perithecium rises free into the air. It appears to be decidedly rare, yet it will doubtless be found sufficiently abundant in localities where its host is more common than it has been found to be by the writer. It varies considerably as to the number of perithecia which it produces as well as the size and number of cells in its intruded base.

ZODIOMYCES Thaxter. Plate XXIII.

Proc. Am. Acad. Arts and Sci. Vol. XXIV, p. 263.

Receptacle attached by a single basal cell, above which it is parenchymatously multicellular, expanding distally; its extremity cup-shaped with a distinct rim, from the inner surface of which arise numerous sterile appendages, surrounding numerous stalked appendiculate perithecia and antheridial branches originating from the central parenchyma. Antherozoids exogenous, rod-like, terminal or short fertile appendages. Spores once-septate near their base.

The present genus is without doubt the most remarkable of the many remarkable members of the family, and presents a degree of vegetative development scarcely to have been looked for

in the group, while the origin of its perithecia is quite unique. Starting with the slender spore, the basal segment of which is far shorter than the terminal, the young plant begins its development by the formation of numerous transverse partitions in both segments (fig. 1). The distal cells give off a variable number of simple branches, and in the mean time longitudinal divisions appear here and there (fig. 2), which become rapidly more numerous (fig. 3) until the main body is for the most part divided into small, very numerous, squarish cells (fig. 4). The main body of the fungus then assumes a more or less clavate form, and is terminated by what may be called the *primary appendage*, the basal cells of which may have a few longitudinal septa (fig. 5), the distal ones producing long, slender branches. A more rapid growth peripherally of the portion below the base of this primary appendage causes the wall-cells in this region to arch outward, producing a more or less distinct cavity, completely enclosed within, as is indicated in fig. 5. As this cavity enlarges, secondary appendages begin to grow inward and upward from the inner surfaces of the cells forming its lateral walls; while from the cells forming its floor the perithecia arise. As a result the secondary appendages break through at the base of the primary appendage, which is turned to one side and soon disappears. This condition is shown in fig. 6, in which the terminal cavity is indicated partly as if seen in section, the secondary appendages having burst out above it and turned the primary appendage to one side, its base being represented at the left. The cavity goes on enlarging till the perithecia begin to be protruded within the circle of secondary appendages (fig. 7); while by further general growth the mature condition is finally reached, as represented in fig. 8. A longitudinal section through the fertile portion of an adult individual then presents the condition shown in fig. 9, which is drawn from a microtome section kindly made for me by Dr. Richards, but is to some extent diagrammatic. Half only of the cup-like extremity is represented, the rim at the right showing the sterile secondary appendages arising from its inner face. The flattened bottom of the cup is seen to consist of crowded parenchyma cells, from which arise directly the perithecia in various stages of development, and the small and inconspicuous antheridial appendages. The latter consist of a few, usually three, superposed, rather short cells, bearing at the tips (figs. 21-23) one to three (usually two) rather large, rod-like bodies, which must be considered exogenous antherozoids, and suggest in a way the spermatia of some lichens. These appear to be formed successively, as in the case of *Ceratomyces*; but owing to the comparatively small size of the antheridia and the difficulty of observing them in crushed specimens, this point could not be definitely ascertained. The antherozoids themselves evidently fall off; since they may frequently be found lying loose about the bases of the perithecial stalks, and in this position they seem to be sought out by the trichogynes, which at first invariably grow downward (figs. 9 and 16).

The development of the perithecium is illustrated by figs. 10 to 20 and fig. 25. They arise primarily as an outgrowth or upgrowth from one of the superficial cells forming the bottom of the cup. This protrusion elongates and becomes divided by two septa into three superposed cells (fig. 13). Of these cells the upper, as far as can be determined, follows a development similar to that by which the perithecium is usually formed in members of the group dividing into two primordial cells (fig. 14), the lower of which forms the perithecium proper, the latter the procarpe. The trichogyne is always simple and terminal, consisting of a filament of variable length, which, as has just been mentioned, grows downward (fig. 16) towards the base of the

stalk. The great variability in the length of the trichogyne is a further indication that it seeks the antherozoids, continuing to elongate until one of the latter becomes fixed to it, after which it is drawn up into a more or less horizontal position through a curvature at its base (fig. 17). In all of the many observed cases, the antherozoid has been found attached to the tip of the trichogyne, a further confirmation of the view just expressed (figs. 17, 18). After the adherence of the antherozoid the trichogyne soon shrivels, remaining for a time as a slight terminal prominence (fig. 25). Meantime one of the cells at the base of the perithecium, perhaps corresponding to the secondary stalk-cell of other instances, produces a curious short, blunt, upturned outgrowth (fig. 19) without visible significance. The four cell-rows of the perithecial wall then become more or less apparent; but the exact number of cells in each is determined with considerable difficulty. Six cells may, however, in favorable specimens be made out, and in the single type species the third cell from the tip of each row produces an appendage. These appendages (figs. 10-12, etc.) are so placed that those arising from the dorsal cell-rows are higher than the others, and arise side by side; while those from the lateral cell-rows spring from opposite sides of the perithecium. They begin to develop by budding outward after the perithecium is nearly mature (fig. 20) and have no special significance, their purpose being probably protective. The terminal cells of the perithecium end each in a short, sharp, slender projection (figs. 9-11). The ascogenic cell appears to be solitary, but this point has not been made out definitely. At maturity the septa of the basal cells of the perithecia are apparently obliterated, as are the cavities of the wall-cells. The main body or receptacle of the mature individual is attached by a single large, slightly colored cell, above which it may produce more or less solid cellular outgrowths, simple, lobed, or even branched, and arising from one or both sides. These outgrowths, which are doubtless designed to prevent sudden lateral bending, are very often wholly wanting even in old individuals. The medullary portion of the receptacle, which lies below the perithecigerous area, is made up of cells charged with dense yellowish fatty protoplasm.

ZODIOMYCES VORTICELLARIUS Thaxter. Plate XXIII, figs. 1-24.

Proc. Am. Acad. Arts and Sci. Vol. XXIV, p. 263; Saccardo Sylloge, Vol. IX, p. 1130.

Hyaline or livid with a central yellowish tinge, often suffused basally with dull purplish above and including the sometimes nearly opaque basal cell. Perithecia numerous, variable in number, each terminal on a slender cylindrical stalk of two superposed cells, becoming sub-lateral through the production of a short lateral upturned blunt outgrowth, arising from a short cell cut off below its base; its apex more or less pointed, curved strongly forward from the base of a pair of blunt rather stout sub-cylindrical or sub-clavate recurved appendages, which arise side by side from its posterior surface; producing laterally on each side, lower than the first, a second appendage, long, slender, curved outward and backward, tapering to a more or less attenuated tip: the body of the perithecium slightly inflated, stouter distally, narrowed towards its base, its basal cells (three?) small and ill defined. Receptacle very variable in size and form, expanding distally to the cup-like extremity from within the margin of which arise numerous crowded, cylindrical, septate, simple or sparingly branched sterile appendages which surround and greatly exceed in length the mass of perithecia; below more or less attenuated, often producing near

the base cellular outgrowths on one or both sides, which vary in form and size. Spores, $45 \times 2.5-3 \mu$. Perithecia, $55 \times 15 \mu$, dorsal appendages, $15-30 \times 5 \mu$, lateral appendages longer, $50 \times 3 \mu$, pedicel, $35-50 \times 3.5-4 \mu$. Sterile appendages longer, $200-220 \times 3-4 \mu$. General receptacle, $220-900 \mu$; width at distal end $90-180 \mu$; the basal outgrowths, longest, 365μ .

On *Hydrocombus lacustris* Lec. and *H. fimbriatus* Melsh. Near New Haven, Connecticut; York, Maine. On an undetermined *Hydrocombus* (?) from Slaughter, Washington (Miss Parker).

This species presents very great variations in size and form, being elongate with a slender base or short and stout; and, though usually nearly symmetrical at maturity, is sometimes very considerably bent or distorted; such differences depending doubtless largely upon the position in which it grows. The basal cushion-like outgrowths, when present, are also very variable in form and size, and are not infrequently once branched. In most instances their cells are arranged with a certain degree of definiteness (fig. 8), but are not infrequently irregularly massed. In its younger conditions, for some time after the perithecia and appendages have broken out, the plant may have a one-sided appearance until the original terminal portion (primary appendage) has sloughed off; after which the cup-shaped extremity becomes usually quite symmetrical. The antheridia are recognized with considerable difficulty, owing to their small size, and do not appear to be very numerous; but young perithecia with trichogynes are always sufficiently abundant.

The species was first found on hosts collected in a brook fed by a pond in West Haven, Conn.; but not in any abundance. More recently sufficient material has been obtained from the brook immediately below Chase's Pond at York, Me., while several specimens were found on an undetermined host, kindly collected for me in Washington by Miss Parker. It is therefore doubtless widely distributed in this country, though perhaps never very common. The hosts are most readily obtained in gravel just at the margins of cool brooks, or in leaves and other rubbish caught on partly submerged rocks or sticks in similar situations, and the parasite, owing to its large size and pale color, is very readily seen, attached to the legs and in various positions on the lower surface of the thorax and abdomen.

CERATOMYCES¹ Thaxter. Plates XXIV-XXV.

Proc. Am. Acad. Arts and Sci. Vol. XXVII, p. 34.

Receptacle consisting of a variable number of superposed cells bearing terminally the perithecium and appendage. Perithecium consisting of four rows of wall-cells, each containing numerous cells, always more than six, often several times this number (seven to sixty-five), the apex various, often with a sub-terminal appendage. Appendage stout, tapering to a branched extremity; consisting of a single series of superposed cells, from the upper inner angle of which may arise branches more or less copious and well developed. Asci clavate, four-spored. Spores acicular, once-septate. Antherozoids long, rod-shaped, exogenous.

The accumulation of numerous species in this genus has rendered its precise description a matter of some difficulty; since, although its characters are well marked, the different species

¹ This name occurs in Streinz, Nomenclator Fungorum, where reference is made to "*Ceratomyces candidus* Sturm." An examination of the citation, however, shows this name to be a misprint for *Crateromyces candidus*.

are remarkably variable. The horn-like appendage, which characterizes the perithecia of the species first described, does not prove of generic value, since it is absent in four forms. The only genus which might possibly be mistaken for it, however, is *Sphaleromyces*; but the presence in this case of flask-shaped antheridia on the branches of the appendage, not to mention its well-developed perithecial stalk-cell, distinguish it without difficulty. Its greatest peculiarity lies in the character and development of the perithecium, which differs from the more typical forms in important points; and although I have been unable to obtain young material which illustrates all the early stages, it appears in *C. mirabilis* to be as follows: The young individual consists of a simple series of superposed cells, the distal of which begin to branch at an early stage; and the first indication of the formation of the perithecium consists in the division by a transverse septum of one of the cells of this series. Of the two cells resulting from this division, the upper grows outward and upward, its outgrowth becoming a finger-like projection (Plate XXIV, fig. 4, at the left) that later elongates to form the filamentous trichogyne. This outgrowth, in the stage represented by the figure, has become divided by two transverse partitions into three cells; the upper being the young trichogyne, the cell below it the trichophoric cell; while below this, not projecting from the axis of the plant, is the smaller carpogenic cell. At the right of the carpogenic cell a vertical septum has divided the remainder of the original upper cell into two parts, an outer and an axile cell; but in other species, like *C. contortus* (Plate XXV, fig. 9), this division seems to be absent. The lower of the two original cells has, in the mean time, been divided by a vertical septum into two cells, one of which (Plate XXIV, fig. 4, *x*) has also begun to grow outward and upward. As far as can be determined, this cell (*x*) by further growth and division produces only one of the series of wall- and canal-cells; while the cell previously referred to as the axile cell, lying behind the carpogenic cell, gives rise to the three other series. Having been unable to separate the cells in this region and ascertain their protoplasmic connections with the cells of the perithecium, it is uncertain whether the above statement is entirely correct in so far as concerns the number of wall-cells originating from each of the cells mentioned; but that they give rise to the outer and inner series of perithecial cells cannot be doubted. The latter grow up around and beyond the carpogenic and trichophoric cells, and by the successive division of their terminal members form the main bulk of the perithecium. The base of the trichogyne is thus left behind, as it were, in the angle between the perithecium and the appendage (Plate XXIV, fig. 5, and Plate XXV, fig. 17), where it often persists for some time. While in other genera, as a rule, only one or two divisions of the perithecial cells takes place above the insertion of the trichogyne, in the present instance the growth beyond it may be almost indefinite; as in *C. rostratus*, for example, or *C. filiformis*, in each of which (Plate XXIV, fig. 15 and 18) the perithecium is extraordinarily developed. Although the general process by which the perithecium originates is thus very similar to that which has been described as characteristic of *Stigmatomyces* or *Laboulbenia*, it will be observed that its basal cells are differently arranged, and originate in a different manner. Whether it is possible to homologize the typical stalk-cell and secondary stalk-cell with any of those present in this case I do not feel able to determine. The perithecial cells of the inner series differ from those of other genera from the fact that they seem to divide quite independently of, and less frequently than, the wall-cells; as may be seen in fig. 8, Plate XXIV, the septa of the wall-cells (*w c*) and of the canal-cell (*c c*) in this instance being by no means coincident. As in other cases, the canal-cells are entirely destroyed by the

pressure of the spore mass, and there are indications that they are absorbed even before this pressure is exerted.

The procarpe, as we have seen, is identical with that of other genera, and the further development of the carpogenic cell, although it has not been traced out in detail, seems to correspond in all respects to that which has been previously described. In species in which it has been possible to determine the number of ascogenic cells with definiteness, four have been seen in every case; but a certain irregularity in the position of the asci in relation to them is often observable, the ordinary biseriate arrangement being at least obscured.

The young individuals of species of this genus bear a close resemblance to those of *Zodiomyces*, and the slender acicular spores, as in the last named genus, are septate nearer to the base than to the apex except in *C. terrestris*. A further peculiarity of the spores is observable in *C. furcatus* and *C. contortus*, in both of which the septum that divides the spore involves its gelatinous envelope also, which is prominently constricted in this region (Plate XXV, figs. 4 and 10).

The trichogyne is always filamentous, usually not very long, and simple or sparingly branched. The antherozoids are clearly differentiated only in *C. rostratus* (Plate XXIV, figs. 21 and 24) and *C. terrestris* (Plate XXV, fig. 23), in both of which they are long, rod-shaped bodies that fall from their attachment soon after they are formed. In other species they appear to result from the segmentation of slender branches into rod-like pieces like those of the two forms mentioned. It is difficult to obtain trichogynes in a receptive condition, and in only a single instance have I found one to which three or four of the long antherozoids were firmly attached.

The species are in a way divisible into sub-groups corresponding to the genera of the hosts which they inhabit. The three species on *Berosus* as well as the four on *Tropisternus* have a distinct family resemblance in either case; while *C. rostratus* is almost sufficiently distinct to be placed in a genus by itself; its chief peculiarity being connected with the production of adventitious branches from about the base of the appendage and perithecium, and the definite and successive production of its antherozoids. It may be mentioned that it is approached in both these respects by the singular little terrestrial form *C. terrestris*. What the near affinities of this peculiar and comparatively imperfectly known genus are, it is difficult to say, although its exogenous antherozoids and the form of its young conditions indicate a nearer relationship with *Zodiomyces* than with any other known forms.

The species all inhabit aquatic beetles of a single family (Hydrophilidæ), with the exception of *C. terrestris*, which is found on a staphylinid that lives in very wet situations.

CERATOMYCES MIRABILIS Thaxter. Plate XXIV, figs. 1-10.

Proc. Am. Acad. Arts and Sci. Vol. XXVII, p. 34; l. c. Vol. XXX, p. 480.

At first pale, becoming more or less deeply suffused with amber-brown. Perithecium straight externally, more or less inflated internally, the cell-rows composed of from twenty to thirty cells, the anterior row ending below the apex in an appendage often equalling the perithecium in length and tapering to a blunt point, or when broken sometimes producing a few slender terminal branches, becoming blackened and inflated near its base, composed of from ten to sixteen

superposed cells. The posterior row terminates opposite the base of this appendage in a bilobed prominence beyond which the short more or less pointed apex is often strongly bent to or towards the base of the perithecial appendage. Antheridial appendage short and stout, usually less than one third as long as the perithecium, sub-conical, with numerous branches produced from its inner side, slender, rather rigid, with more or less divergent branchlets. Receptacle consisting of three superposed cells, followed by two cells; the posterior larger and followed by the basal cells of the appendage; the anterior much smaller, followed by a second cell about equalling it in size, beyond which follows the base of the perithecium: the basal cell wholly or partly hyaline or translucent above the large jet black foot; the remaining cells deeply blackened except along their anterior edges, the blackening involving the base of the antheridial appendage. Spores, $110-120 \times 4 \mu$. Perithecia, $280-300 \times 65-70 \mu$, longest, 330μ , its appendage, $180-200 \mu$. Total length to tip of perithecium, $400-525 \mu$. Antheridial appendage (exclusive of its branches) about one third as long as the perithecium.

On *Tropisternus glaber* Hb. and *T. nimbatus* Say, Milford, Connecticut; Arlington, Mass.; Kittery Point, Maine.

This species, though perhaps the commonest member of the genus, seems never very abundant. It is subject to a good deal of variation in size, but is otherwise very constant in its characters and easily distinguished from the rarer *C. confusus*. It is found on the lower surface of the abdomen and thorax of its host, especially along the margin of the former on the left side, and is conspicuous from its large size.

It may be mentioned that this species, and probably the succeeding, is subject to the external parasitism of a Chytridiaceous parasite of singular structure resembling the Obelidium of Nowakowski in some respects, but apparently belonging to an undescribed genus. The development of this plant has not, however, been as yet fully made out.

CERATOMYCES CONFUSUS Thaxter. Plate XXIV, figs. 11, 12.

Proc. Am. Acad. Arts and Sci. Vol. XXX, p. 480.

General habit and color as in *C. mirabilis*. Perithecium hardly inflated, its inner margin curving evenly to the prominent blunt apex which stands out free from the base of the perithecial appendage. The perithecial appendage shorter and usually stouter than in *C. mirabilis*, without the bulbous inflation at its base. Axis of antheridial appendage long and slender, distally attenuated, with comparatively few short branches. Receptacle as in *C. mirabilis*. Spores, $75-90 \times 3.7 \mu$. Perithecia, $235-335 \times 65 \mu$. Axis of antheridial appendage 235μ (longest). Receptacle, $165 \times 75 \mu$.

On *Tropisternus glaber* Hb. and *T. nimbatus* Say, Milford, Connecticut, and Kittery Point, Maine.

This species is much rarer than *C. mirabilis*, and is at once distinguished by the absence of any posterior prominences below the apex of the perithecium, as well as by the differences presented by its perithecial and antheridial appendages. Its spores also seem constantly smaller, and although the two species are so strikingly similar, it is unlikely that they are mere varieties of a single form. It occurs, like the preceding species, along the inferior margin of its host's body, but almost always on the opposite (right) side.

CERATOMYCES CAMPTOSPORUS Thaxter. Plate XXIV, figs. 13, 14.

Proc. Am. Acad. Arts and Sci. Vol. XXVII, p. 35.

Pale amber-brown. Perithecium strongly curved near the base, rather stout, its cell-rows made up of from thirty-five to forty members which, on the anterior row, are somewhat inflated and constricted at the septa, giving a strongly corrugated outline on this side, the inner margin bent abruptly almost at right angles to the blunt tip, below which, externally, a nearly straight erect perithecial appendage arises, composed of six or more superposed cells, sometimes bearing terminal branchlets. Antheridial appendage consisting of a short curved basal cell, above which it is abruptly expanded, tapering thence to a rather slender tip; the antheridial branchlets terminal, few in number (or wholly broken off). Receptacle very small, consisting of a few superposed cells for the most part black and opaque. Spores slightly swollen, and bent near the apex, long and slender, $110 \times 3.5 \mu$. Perithecia, $275 \times 85-90 \mu$. Receptacle, $90 \times 50 \mu$.

On *Tropisternus glaber* Hb., Milford, Connecticut; Arlington, Mass. On *T. striolatus* Lec., Texas.

This species appears to be very rare, and I have collected it but once since the three types were found at Milford. A specimen on the above-mentioned host from Texas seems to correspond in all essentials, though not in very good condition, and is more rigid in form without the sub-sigmoid habit of the other specimens. The type-form is at once distinguished by the character of its antheridial appendage, the form of its perithecium, and especially by its greatly reduced and almost wholly blackened receptacle and the characteristic irregularity of its spores. It is found along the lower margin of its host, but was attached to the edge of the elytron in the only specimen in which its exact position was noted.

CERATOMYCES FILIFORMIS Thaxter. Plate XXIV, figs. 15-17.

Proc. Am. Acad. Arts and Sci. Vol. XXVIII, p. 187.

Suffused with dark amber-brown. Receptacle consisting of three superposed cells, the basal one partly blackened, surmounted by two cells which form the origin of the perithecium and antheridial appendage. Perithecium very long and slender, hardly inflated, tapering abruptly and symmetrically to the subtruncate apex, the cell-rows composed of very numerous cells (maximum forty-five). Appendage short, tapering, straight, bearing terminally or sub-terminally one or two slender branches. Spores, $55-60 \times 3 \mu$. Perithecia, $250-330 \times 33-40 \mu$. Receptacle, $35 \times 85 \mu$. Appendage, 90μ .

On the edge of the elytra of *Tropisternus glaber* (Hb.) and *T. nimbatus* Say, Milford, Connecticut; Arlington, Mass., and Kittery Point, Maine.

This species was at first taken for an abnormal form, but sufficient material shows that it is a well-marked species. It occurs near the tip of the elytron on the upper surface, and is with difficulty distinguished from the bristle-like hairs among which it occurs. It is remarkable for the very small number of spores present in the perithecium, which is more commonly almost empty, especially in specimens in which there are the greatest number of wall-cells. It is never found in abundance and seems decidedly rare.

CERATOMYCES MINISCULUS Thaxter. Plate XXV, figs. 15-18.

Proc. Am. Acad. Arts and Sci. Vol. XXVIII, p. 187.

Becoming more or less deeply tinged with amber-brown. Receptacle consisting of about three superposed basal cells, all blackened, opaque, and indistinguishable, surmounted by a few small cells partly blackened below, from which arise the appendage and perithecium. Perithecium sub-conical, ten or eleven cells in each cell-row, a short blunt conical unicellular projection borne sub-laterally below the tip, which is usually curved slightly outward. Appendage tapering to a slender tip, simple, or bearing a few short branches near its apex, seldom as long as the perithecium. Spores, $75 \times 4 \mu$. Perithecia, $110-150 \times 30-40 \mu$. Receptacle, average, $90 \times 40 \mu$. Appendage, $50-110 \mu$ long.

On *Tropisternus nimbatus* Say, Kittery Point, Maine; Milford, Connecticut; Texas.

This curious little species occurs rather rarely, growing appressed on the lower surface of the hyaline outer margin of the right elytron of its host, usually near the tip, and is readily distinguished by its relatively large jet-black receptacle, which is about as large as the perithecium itself. It is not readily obtained in good condition.

CERATOMYCES TERRESTRIS Thaxter. Plate XXV, figs. 19-24.

Proc. Am. Acad. Arts and Sci. Vol. XXIX, p. 94.

Nearly hyaline, with black or dark brown suffusions. Perithecium large, slightly inflated, tapering to a bluntly rounded or truncate apex, from which the sharply pointed lips project; the wall of the perithecium consisting of four series of about twelve cells each, its base formed from three small cells, below which a single similar small cell connects it with the receptacle. Receptacle consisting of three small superposed squarish cells, the upper of which gives rise to the perithecium and the appendage. The appendage, consisting of six or more superposed, flattened cells becoming externally suffused with blackish brown or black (the suffusion sometimes involving the whole series as well as the entire receptacle, with the exception of its basal cell), bearing on its inner side numerous hyaline branches simple or once or twice branched, the lower arising from a series of small cells which may extend across the base of the perithecium on one side. Spores, $15 \times 2.5-3 \mu$. Perithecium, $75-90 \times 22-29 \mu$. Receptacle, 25μ long. Total length to tip of perithecium, $100-140 \mu$, to tip of main appendage, $45-65 \mu$. Longest branches of appendage, 75μ .

On *Lathrobium punctulatum* Lec., Kittery Point, Maine; Arlington, Mass.

This minute and curious species is chiefly interesting from the fact that it is a terrestrial form in a typically aquatic genus, of which, however, it seems to possess all the essential characters. In contrast to its congeners, it is among the smallest of all the Laboulbeniaceæ, and is very readily overlooked. It inhabits the legs of its host as a rule, but is sometimes found on the abdomen. It varies considerably in the number of branches which arise from the appendage or from cells near its base, and some of these branches are peculiar, for what appears to be a gelatinous modification of their tips, which result in the clavate form shown in figs. 20-21. In the majority of specimens the branches are wholly broken off, as in figs. 19 and 22. Unlike the other species of the genus, the spores appear to be septate near the apex.

CERATOMYCES ROSTRATUS Thaxter. Plate XXIV, figs. 18-27.

Proc. Am. Acad. Arts and Sci. Vol. XXVIII, p. 188.

Reddish or amber-brown. Receptacle long, slender, expanding slightly upward, consisting of about twelve superposed cells. Perithecium consisting of a clearly distinguished neck and an inflated oval basal portion, completely filled with spores and asci, which pushes the appendage to one side and continues directly the axis of the receptacle; the neck very elongate, irregularly cylindrical, straight or its terminal portion at maturity (in perfectly developed specimens) abruptly bent upon itself, the recurved portion tapering slightly to the hunched asymmetrical apex; the cell-rows made up of seventy cells, more or less. Appendage arising from a broad base flattened at maturity by pressure from the base of the perithecium, consisting of about six superposed cells bearing numerous branches, which may in turn be several times branched. Spores about $75 \times 3.5 \mu$. Perithecia, basal portion, $110-150 \times 65-90 \mu$; neck, including recurved portion, longest, 1.17 mm. Appendage about $90-100 \mu$ long, its longest branches about 200μ . Receptacle, large, about 260μ long by 55μ at the distal end.

On *Hydrocombis fimbriatus* Melsh., Massachusetts, Texas; *Philhydrus cinctus* Say, Maine. A variety on *P. nebulosus* Say, Maine.

The most remarkable species of the genus, the enormously elongated neck of the perithecium becoming hooked only in fully mature specimens, and serving an evident purpose in the spore dissemination during coitus.

In perhaps a majority of specimens the neck is shorter and straight, and there are very considerable variations in size and form. The appendage is often very broad at its base, and projects outward, often at a considerable angle; while its basal cells may be irregularly divided and produce branches which, in some cases, even seem to arise from the lower perithecial wall-cells, forming a rather dense tuft, while in other cases they are more sparingly developed. The number of cells composing the receptacle is subject to considerable variation; and the cell-rows of the perithecium present very great differences in the number of their component cells. Unlike any other species, there is a distinct differentiation between the terminal conductive portion of the perithecium and its inflated ascigerous base, which is, apparently through pressure of its contents, hardly distinguished in many cases from the base of the appendage. The antheridial branches and the antherozoids of this species, which are peculiar in many respects, have been already alluded to (p. 210). The typical form is probably widely distributed, and is not uncommon in the brook below the cascade at Waverly and in some other localities about Boston. A few specimens were also obtained from a Texan specimen of *Hydrocombis* in the Museum collection, and it occurs rarely on *Philhydrus cinctus* at Kittery Point, Maine. A small variety which should not, I think, be separated specifically from the present form, occurs on the lower surface of the elytra of *P. nebulosus* Say, near the tip or the outer margin, and is represented in figs. 26, 27. Although so very much smaller, and apparently always confined to the situation mentioned, it possesses no essential differences by which it can be distinguished from many forms of the present species, which is found on the inferior surface of the abdomen and thorax of its host and not unfrequently on the legs. It is subject to the attack of a chytridiaceous parasite similar to that which occurs on *C. mirabilis*, but specifically distinct.

CERATOMYCES FURCATUS Thaxter. Plate XXV, figs. 1-4.

Proc. Am. Acad. Arts and Sci. Vol. XXVIII, p. 186.

Hyaline, becoming more or less suffused with reddish brown, the appendages sometimes purplish. Receptacle composed of three or four superposed cells, surmounted by two cells, from which arise the perithecium and appendage. Perithecium large and stout, externally nearly straight, inwardly inflated and strongly curved to the pointed apex, below which arises externally and sub-laterally a large, stout, flexed appendage, tapering and bearing toward its tip a single row of short branches, which may be in turn once branched. Cell-rows of perithecium each consisting of about eight cells. Antheridial appendage very large, consisting of twenty cells (more or less) bearing branches at irregular intervals from its inner surface. Spores, $85-90 \times 4 \mu$. Perithecia, $130-150 \times 45-60 \mu$. Receptacle, $90-110 \times 45-55 \mu$. Antheridial appendage, $300-425 \mu$. Perithecial appendage about 325μ .

On *Berosus striatus* Say, Maine.

This singular-looking species occurs, so far as I have observed, only on the right side of the lower surface of the thorax in small groups. Its very large antheridial appendages distinguish it from other species, and give it the Y or V form which has suggested the specific name. The spores, like those of *C. contortus*, are peculiar in that the septum involves also the gelatinous envelope. It seems to be a decidedly rare form, and with *C. humilis* and the last mentioned species, all occurring on the same host, has been thus far found only at Kittery Point, Maine, in a small pond near the highest point of Cutts Island.

CERATOMYCES CONTORTUS Thaxter. Plate XXV, figs. 5-10.

Proc. Am. Acad. Arts and Sci. Vol. XXVIII, p. 186.

Hyaline, becoming very faintly brownish. Receptacle consisting of three superposed cells, above which three cells form the general base of the perithecium and appendage. Perithecium long and slender, usually constricted at the base so as to appear short stalked, slightly inflated and bent outward, the apex pointed and curved. A short appendage arises sub-laterally below the apex and is strongly curved, extending inward beyond the apex, its fifth and sometimes also its sixth cell producing from its upper surface a stout branch which may be simple or may bear secondary branches at irregular intervals. Antheridial appendage consisting of about twelve superposed cells, producing a few branches from its inner side at irregular intervals, the branches in turn more or less irregularly branched. Spores, $80-85 \times 3-3.5 \mu$. Perithecia, $200-260 \times 35-45 \mu$. Receptacle about 125μ long. Antheridial appendage, $110-130 \mu$. Perithecial appendage, 75μ long.

On *Berosus striatus* Say, Kittery Point, Maine.

This species is somewhat more frequently met with than the preceding, and is usually found on the lower surface of the abdomen on the left side near its tip. It is readily distinguished from *C. furcatus* by its more slender habit, almost stalked perithecium, much smaller appendages and generally malformed and distorted habit. It has as yet been found only in the locality men-

tioned under the preceding species, to which it is most nearly allied. As already stated, its spores are peculiar for the constriction about their septum, which involves the gelatinous envelope.

CERATOMYCES HUMILIS Thaxter. Plate XXV, figs. 11-14.

Proc. Am. Acad. Arts and Sci. Vol. XXIX, p. 94.

Hyaline, becoming faintly tinged with brownish. Perithecium rather narrow, without any appendage, the apex blunt or nearly truncate, its cell-rows composed of not more than seven cells. Receptacle composed of from two to five superposed squarish cells. Appendage consisting of six to twelve superposed cells, the series tapering distally and producing irregularly from its inner face branches which may in turn be several times branched and may reach a length twice that of the perithecium. Spores, $22 \times 3 \mu$. Perithecia, $100 \times 25 \mu$. Total length to tip of perithecium, $150-185 \mu$. Longest branches of appendage, 180μ .

On *Berosus striatus* Say, Kittery Point, Maine.

A somewhat insignificant species allied to *C. contortus*, from which it is easily distinguished by its small size and by the absence of any appendage near the tip of the perithecium. It occurs more frequently between the terminal claws of the middle pair of legs, but is rarely found on the elytra. In two specimens the perithecia have become distinctly tinged with brown, but as a rule the whole plant is hyaline.

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INDEX OF HOST INSECTS.

NAME OF HOST INSECT.

NAME OF PARASITE.

COLEOPTERA.

CARABIDÆ.

Acrogenys hirsuta Maclean,	Laboulbenia australiensis Thaxter.
Acupalpus carus Lec.,	Rhachomyces lasiophorus Thaxter.
Agonoderus pallipes Fabr.,	Laboulbenia polyphaga Thaxter.
Amara sp. indet.,	" " "
Anisodactylus baltimorensis Say,	" compressa Thaxter.
" " "	" elongata Thaxter.
" " "	" macrotheca Thaxter.
" Harrisii Lec.,	" filifera Thaxter.
" interpunctatus Kirby,	" " "
" nigerrimus Dej.,	" " "
" " "	" lepida Thaxter.
" " "	" Pterostichi Thaxter.
" spp. indet.,	" filifera Thaxter.
" " "	" macrotheca Thaxter.
" " "	" variabilis Thaxter.
Anomoglossus pusillus Say,	
Anopthalmus Bilimeki Sturm.,	Rhachomyces hypogæus Thaxter.
" Menetriesii Motsch.,	Laboulbenia subterranea Thaxter.
" Motschulskyi Schm.,	" " "
" pusio Horn,	Rhachomyces speluncalis Thaxter.
" tenuis Horn,	Laboulbenia sp. indet.
Aptinus mutilatus Fabr.,	" europæa Thaxter.
Aspidoglossa subangulata Chaud.,	" Aspidoglossæ Thaxter.
Atranus pubescens Dej.,	Rhachomyces lasiophorus Thaxter.
" " "	Eucantharomyces Atrani Thaxter.
Badister maculatus Lec.,	Laboulbenia polyphaga Thaxter.
" micans Lec.,	Rhachomyces lasiophorus Thaxter.
Bembidium Andreæ F.,	Laboulbenia vulgaris Peyritsch.
" bimaculatum Kirby,	" curtipes Thaxter.
" bipunctatum Duft.,	" vulgaris Peyritsch.
" " "	" luxurians Peyritsch.
" complanulum Mann.,	" cornuta Thaxter.
" decorum Pz.,	" vulgaris Peyritsch.
" fasciolatum Duft.,	" " "
" femoratum Sturm.,	" " "
" flammulatum Clairv.,	" " "
" " "	" luxurians Peyritsch.
" lævigatum Say,	" vulgaris Peyritsch.
" littorale Pz.,	" " "
" lunatum Duft.,	" " "
" " "	" flagellata Peyritsch.

NAME OF HOST INSECT.	NAME OF PARASITE.
Bembidium mexicanum Dej.,	<i>Laboulbenia vulgaris</i> Peyritsch.
“ obsoletum Dej.,	“ “ “
“ punctulatum Drap.,	“ “ “
“ varium Oliv.,	“ <i>luxurians</i> Peyritsch.
Blethisa multipunctata Fabr.,	“ <i>variabilis</i> Thaxter.
“ quadricollis Bald.,	“ “ “
Brachinus crepitans L.,	“ <i>Rougetii</i> Mont. and Robin.
“ explodens Duft.,	“ “ “ “
“ “ “	“ <i>europæa</i> Thaxter.
“ mexicanus Dej.,	“ <i>Brachini</i> Thaxter.
“ scolopeta Fabr.,	“ <i>Rougetii</i> Mont. and Robin.
“ spp. indet. ,	“ <i>Brachini</i> Thaxter.
“ “	“ <i>texana</i> Thaxter.
Bradycellus rupestris Say,	“ <i>inflata</i> Thaxter.
Callida pallidipennis Chaud.,	“ <i>minima</i> Thaxter.
Callistus lunatus Fabr.,	“ <i>europæa</i> Thaxter.
Casnonia pennsylvanica Linn.,	“ <i>Casnoniæ</i> Thaxter.
Catascopus guatemalensis Bates,	“ <i>Catascopi</i> Thaxter.
“ spp. indet. ,	“ “ “
Chlænius æneocephalus Dej.,	“ <i>europæa</i> Thaxter.
“ æstivus Say,	“ <i>variabilis</i> Thaxter.
“ chrysocephalus Rossi,	“ <i>europæa</i> Thaxter.
“ cumatilis Lec,	“ <i>variabilis</i> Thaxter.
“ cursor Chev.,	“ “ “
“ floridanus Horn,	“ “ “
“ leucoscelis Chaud.,	“ “ “
“ pennsylvanicus Say,	“ “ “
“ ruficauda Chaud.,	“ “ “
“ sparsus Lec.,	“ “ “
“ tenuicollis Fabr.,	“ <i>proliferans</i> Thaxter.
“ texanus Horn,	“ <i>variabilis</i> Thaxter.
“ tricolor Dej.,	“ “ “
“ velutinus Duft.,	“ <i>proliferans</i> Thaxter.
“ vestitus F.,	“ <i>fasciculata</i> Peyritsch.
“ viridicollis Reiche,	“ <i>variabilis</i> Thaxter.
“ spp. indet. ,	“ “ “
Clivina cordata Pz.,	“ <i>Schizogenii</i> Thaxter.
“ dentifemorata Pz.,	“ <i>Clivinæ</i> Thaxter.
“ dentipes Dej.,	“ “ “
Colpodes cæruleomarginatus , Chaud.,	“ <i>elongata</i> Thaxter.
“ cyanonotus Chaud.,	“ “ “
“ duplex Bates,	“ “ “
“ grata Bates,	“ “ “
“ evanescens Bates,	“ <i>Rhachomyces longissimus</i> Thaxter.
“ incultus Bates,	“ <i>Laboulbenia elongata</i> Thaxter.
“ purpuripennis Chaud.,	“ “ “
“ sphodroides Chaud.,	“ “ “
“ petilus Bates,	“ “ “
“ tenuicornis Chaud.,	“ “ “
“ spp. indet. ,	“ “ “
Coptodera Championi Bates,	“ <i>Coptoderæ</i> Thaxter.
Crepidogaster bimaculata Boh.,	“ <i>zanzibarina</i> Thaxter.
Dolichus ? sp. indet. ,	“ <i>proliferans</i> Thaxter.
Eudema tropicum Hope,	“ “ “

NAME OF HOST INSECT.	NAME OF PARASITE.
Eudemis sp. indet.,	Laboulbenia proliferans Thaxter.
Galerita æquinoctialis Chaud.,	" decipiens Thaxter.
" " "	" mexicana Thaxter.
" atripes Lec.,	" Galeritæ Thaxter.
" Janus Fabr.,	" " "
" leptodera Chaud.,	" longicollis Thaxter.
" mexicana Dej.,	" Galeritæ Thaxter.
" " "	" melanotheca Thaxter.
" " "	" mexicana Thaxter.
" nigra Chev.,	" " "
" sp. indet.,	" decipiens Thaxter.
" " "	" longicollis Thaxter.
Harpalus erythropus Dej.,	" filifera Thaxter.
" pennsylvanicus DeG.,	" arcuata Thaxter.
" " "	" conferta Thaxter.
" " "	" elegans Thaxter.
" " "	" Harpali Thaxter.
" pfeuriticus Kirby	" polyphaga Thaxter.
Læmosthenes cavicola Sch.,	" elongata Thaxter.
Loxandrus spp. indet.,	" polyphaga Thaxter.
Macrochilus biguttatus Goeze,	" elongata Thaxter.
Morio Georgii Pal.,	" Morionis Thaxter.
Mormolyce phyllodes Hagenb.,	" Kunkeli (Giard).
" " "	" palmella Thaxter.
Nebria brunnea Duft.,	" Nebriæ Peyritsch.
" gregaria Fisch.,	" " "
" pallipes Say,	" " "
" Sahlbergi Fisch.,	" " "
" villæ Dej.,	" " "
Olisthopus parvatus Say,	" polyphaga Thaxter.
Omophron americanum Dej.,	" variabilis Thaxter.
" limbatum F.,	" fasciculata Peyritsch.
" sp. indet.,	" variabilis Thaxter.
Pachyteles luteus Hope,	Dimeromyces africanus Thaxter.
" mexicanus Chaud.,	Laboulbenia Pachytelis Thaxter.
Panagæus crucigerus Say,	" Panagæi Thaxter.
" fasciatus Say,	" " "
Patrobus longicornis Say,	" brachiata Thaxter.
" " "	" variabilis Thaxter.
" tenuis Say,	" brachiata Thaxter.
Pheropsophus æquinoctialis Linn.,	" Pheropsophi Thaxter.
" (?) marginatus Dej.,	" " "
" spp. indet.,	" " "
" " "	Enarthromyces indicus Thaxter.
Platynus æruginosus Dej.,	Laboulbenia parvula Thaxter.
" affinis Kirby,	" contorta Thaxter.
" bicolor Lec.,	" elongata Thaxter.
" brunneomarginatus Mann.,	" " "
" cincticollis Say,	" " "
" " "	" fumosa Thaxter.
" " "	Peyritschella curvata Thaxter.
" " "	" minima Thaxter.
" dissectus Lec.,	Laboulbenia elongata Thaxter.
" extensicollis Say,	" " "

NAME OF HOST INSECT.	NAME OF PARASITE.
Platynus extensicollis Say,	Laboulbenia contorta Thaxter.
" " "	" gibberosa Thaxter.
" " "	" parvula Thaxter.
" " "	" paupercula Thaxter.
" " "	" recta Thaxter.
" " "	" scelophila Thaxter.
" " "	" variabilis Thaxter.
" floridanus Lec.,	" elongata Thaxter.
" melanarius Dej.,	" " "
" " "	" paupercula Thaxter.
" ovipennis Mann.,	" elongata Thaxter.
" picticornis Newm.,	" " "
" pusillus Lec.,	" " "
" ruficornis Lec.,	" " "
" sinuatus Dej.,	" " "
" viduus Pz.,	" anceps Peyritsch.
Pristonychus , see Læmosthenes .	
Pterostichus adoxus Say,	" variabilis Thaxter.
" caudicalis Say,	" " "
" corvinus Dej.,	" " "
" erythropus Dej.,	Peyritschella geminata Thaxter.
" luctuosus Dej.,	" " "
" " "	Laboulbenia Pterostichi Thaxter.
" " "	" terminalis Thaxter.
" " "	" variabilis Thaxter.
" mancus Lec.,	" Pterostichi Thaxter.
" patruelis Dej.,	Peyritschella geminata Thaxter.
" " "	Laboulbenia rigida Thaxter.
" relictus Newm.,	" variabilis Thaxter.
" Sayi Bruellé,	" " "
" vel. affin. (S. Amer.)	" " "
Schizogenius ferrugineus Pz.,	" Schizogenii Thaxter.
" lineolatus Say,	" " "
Stenolophus fuliginosus Dej.,	" polyphaga Thaxter.
" limbalis Lec.,	" " "
" ochropezus Say,	" umbonata Thaxter.
Trechus chalybeus Mann.,	" vulgaris Peyritsch.

HALIPLIDÆ.

Cnemidotus muticus Lec.,	Hydræomyces Halipli Thaxter.
Haliplus ruficollis DeG.,	" " "

DYTISCIDÆ.

Bidessus granarius Aube,	Chitonomyces bidessarius Thaxter.
Desmopachria convexa Aube,	" aurantiacus Thaxter.
" " "	" borealis Thaxter.
Hydroporus spurius Lec.,	" marginatus Thaxter.
" " "	" rhyncostoma Thaxter.
" " "	" simplex Thaxter.
" " "	" uncinatus Thaxter.
Laccophilus hyalinus Dej.,	" paradoxus (Peyritsch).
" " "	" melanurus Peyritsch.
" minutus Sturm.,	" " "
" " "	" paradoxus (Peyritsch).

NAME OF HOST INSECT.			NAME OF PARASITE.	
Laccophilus maculosus Germ.,	.	.	Chitonomyces affinis Thaxter.	
"	"	"	"	appendiculatus Thaxter.
"	"	"	"	distortus Thaxter.
"	"	"	"	hyalinus Thaxter.
"	"	"	"	lichenophorus Thaxter.
"	"	"	"	marginatus Thaxter.
"	"	"	"	paradoxus (Peyritsch).
"	"	"	"	rhyncostoma Thaxter.
"	"	"	"	simplex Thaxter.
"	"	"	"	spinigerus Thaxter.
"	"	"	"	uncigerus Thaxter.
"	"	"	"	uncinatus Thaxter.
"	sp. indet.,	.	"	affinis Thaxter.
"	"	"	"	marginatus Thaxter.
"	"	"	"	paradoxus (Peyritsch).
"	"	"	"	uncigerus Thaxter.

GYRINIDÆ.

Gyretes compressus Lec.,	.	.	Laboulbenia Guerinii Mont. and Robin.	
"	sericeus Lab.,	.	"	" " "
Gyrinus affinis Aube,	.	.	"	Gyrinidarum Thaxter.
"	analisis Say,	.	"	" "
"	confinis Lec.,	.	"	" "
"	fraternus Coup.,	.	"	" "
"	plicifer Lec.,	.	"	" "
"	urinator Illig.,	.	"	" "
"	ventralis Kirby,	.	"	" "
Orectogyros heros Reg.,	.	.	"	Oberthuri Giard.
"	Bedeli Reg.,	.	"	Orectogyri Thaxter.

HYDROPHILIDÆ.

Berosus striatus Say,	.	.	Ceratomyces contortus Thaxter.	
"	"	"	"	furcatus Thaxter.
"	"	"	"	humilis Thaxter.
Hydrocombus fimbriatus Melsh.,	.	.	"	rostratus Thaxter.
"	"	"	Zodiomyces vorticellarius Thaxter.	
"	lacustris Lec.,	.	"	" "
"	sp. indet.,	.	"	" "
Philhydrus cinctus Say,	.	.	Ceratomyces rostratus Thaxter.	
"	nebulosus Say,	.	"	" "
Tropisternus glaber Hb.,	.	.	"	camptosporus Thaxter.
"	"	"	"	confusus Thaxter.
"	"	"	"	filiformis Thaxter.
"	"	"	"	mirabilis Thaxter.
"	nimbatus Say,	.	"	confusus Thaxter.
"	"	"	"	filiformis Thaxter.
"	"	"	"	minisculus Thaxter.
"	"	"	"	mirabilis Thaxter.
"	striolatus Lec.,	.	"	camptosporus Thaxter.

STAPHYLINIDÆ.

Actobius nanus Horn,	.	.	Teratomyces Actobii Thaxter.	
"	"	"	"	brevicaulis Thaxter.
"	"	"	Diplomyces Actobianus Thaxter.	
Acylophorus flavicollis Sachs,	.	.	Teratomyces mirificus Thaxter.	

NAME OF HOST INSECT.	NAME OF PARASITE.
<i>Acylophorus flavipes</i> Lec.,	<i>Teratomyces mirificus</i> Thaxter.
“ <i>pronus</i> Er.,	“ “ “
<i>Bledius armatus</i> Er.,	<i>Cantharomyces occidentalis</i> Thaxter.
“ <i>assimilis</i> (ms. name ?)	“ <i>Bledii</i> Thaxter.
“ <i>basalis</i> Lec.,	“ <i>Amorphomyces</i> “ <i>floridanus</i> Thaxter.
“ <i>emarginatus</i> Say,	<i>Haplomyces virginianus</i> Thaxter.
“ <i>ornatus</i> Lec.,	“ <i>californicus</i> Thaxter.
“ <i>rubiginosus</i> Er.,	“ <i>texanus</i> Thaxter.
<i>Cryptobium bicolor</i> Grav.,	<i>Corethromyces Cryptobii</i> Thaxter.
“ <i>pallipes</i> Grav.,	“ “ “
<i>Deleaster dichrous</i> Grav.,	<i>Idiomyces Peyritschii</i> Thaxter.
<i>Falagria dissecta</i> Er.,	<i>Amorphomyces Falagriæ</i> Thaxter.
“ “ “	<i>Dimorphomyces denticulatus</i> Thaxter.
“ “ “	“ <i>muticus</i> Thaxter.
<i>Lathrobium angulare</i> Lec.,	<i>Rhadinomyces pallidus</i> Thaxter.
“ <i>collare</i> Ehr.,	<i>Corethromyces jacobinus</i> Thaxter.
“ <i>fulvipenne</i> Grav.,	<i>Rhachomyces pilosellus</i> (Robin).
“ “ “	<i>Rhadinomyces pallidus</i> Thaxter.
“ <i>jacobinum</i> Lec.,	<i>Corethromyces jacobinus</i> Thaxter.
“ <i>longiusculum</i> Grav.,	<i>Rhachomyces Lathrobii</i> Thaxter.
“ <i>nitidulum</i> Lec.,	<i>Corethromyces setigerus</i> Thaxter.
“ “ “	<i>Rhadinomyces cristatus</i> Thaxter.
“ “ “	<i>Sphaleromyces Lathrobii</i> Thaxter.
“ <i>punctulatum</i> Lec.,	<i>Ceratomyces terrestris</i> Thaxter.
“ “ “	<i>Rhadinomyces cristatus</i> Thaxter.
“ “ “	“ <i>pallidus</i> Thaxter.
“ “ “	<i>Sphaleromyces Lathrobii</i> Thaxter.
“ <i>tenue</i> Lec.,	<i>Corethromyces setigerus</i> Thaxter.
<i>Lathrobium vel</i> affin.,	<i>Rhachomyces arbusculus</i> Thaxter.
<i>Othius fulvipennis</i> Fabr.,	“ <i>furcatus</i> Thaxter.
<i>Pæderus littorarius</i> Grav.,	<i>Laboulbenia cristata</i> Thaxter.
“ <i>obliteratus</i> Lec.,	“ “ “
“ <i>ruficollis</i> Fabr.,	“ “ “
“ spp. indet.,	“ “ “
<i>Philonthus æqualis</i> Horn,	“ <i>Philonthi</i> Thaxter.
“ <i>cunctans</i> Horn,	“ “ “
“ <i>debilis</i> Grav.,	<i>Dichomyces furciferus</i> Thaxter.
“ “ “	“ <i>inæqualis</i> Thaxter.
“ “ “	<i>Peyritschella nigrescens</i> Thaxter.
“ “ “	<i>Laboulbenia Philonthi</i> Thaxter.
“ <i>furvus</i> Nord.,	“ “ “
“ <i>micans</i> Grav.,	“ “ “
“ <i>sordidus</i> Grav.,	<i>Dichomyces princeps</i> Thaxter.
“ spp. indet.,	<i>Laboulbenia Philonthi</i> Thaxter.
<i>Pinophilus densus</i> Lec.,	<i>Sphaleromyces occidentalis</i> Thaxter.
“ <i>latipes</i> Ehr.,	<i>Chætomyces Pinophili</i> Thaxter.
<i>Quedius ferox</i> Lec.,	<i>Teratomyces Quedianus</i> Thaxter.
“ <i>vernix</i> Lec.,	<i>Laboulbenia Quedii</i> Thaxter.
<i>Sunius longiusculus</i> Mann.,	<i>Camptomyces melanopus</i> Thaxter.
“ “ “	<i>Compsomyces verticillatus</i> Thaxter.
“ <i>prolixus</i> Ehr.,	<i>Camptomyces melanopus</i> Thaxter.
“ “ “	<i>Moschomyces insignis</i> Thaxter.
<i>Tachinus pallipes</i> ,	gen. indet.
<i>Trogophlæus</i> spp. indet.,	<i>Cantharomyces pusillus</i> Thaxter.
<i>Xantholinus obsidianus</i> Melsh.,	<i>Dichomyces infectus</i> Thaxter.

NAME OF HOST INSECT.

NAME OF PARASITE.

COCCINELLIDÆ.

Chilocorus bivulnerus Muls., *Stigmatomyces virescens* Thaxter.

DIPTERA.**DIOPSIDÆ.**

Diopsis thoracica Westw., *Laboulbenia Diopsis* Thaxter.
 " " " *Rhizomyces ctenophorus* Thaxter.

DROSOPHILIDÆ.

Drosophila nigricornis Loew., *Stigmatomyces entomophilus* (Peck).
 " *funebis* L., " " "

MUSCIDÆ.

Musca domestica L., *Stigmatomyces Baeri* Peyritsch.

NYCTERIBIDÆ.

Acrocholidia Montaguei Kol., *Helminthophana Nycteribiæ* Peyritsch.
Megistopoda Westwoodii Kol., " " "
Nycteribia Dufourii, " " "

NEUROPTERA.**TERMITES.**

Termes mozambica Hagen, *Laboulbenia Hageni* Thaxter.

ARACHNIDA.**GASPIDÆ.**

Antennophorus caput-carabis, *Laboulbenia armillaris* Berlese.

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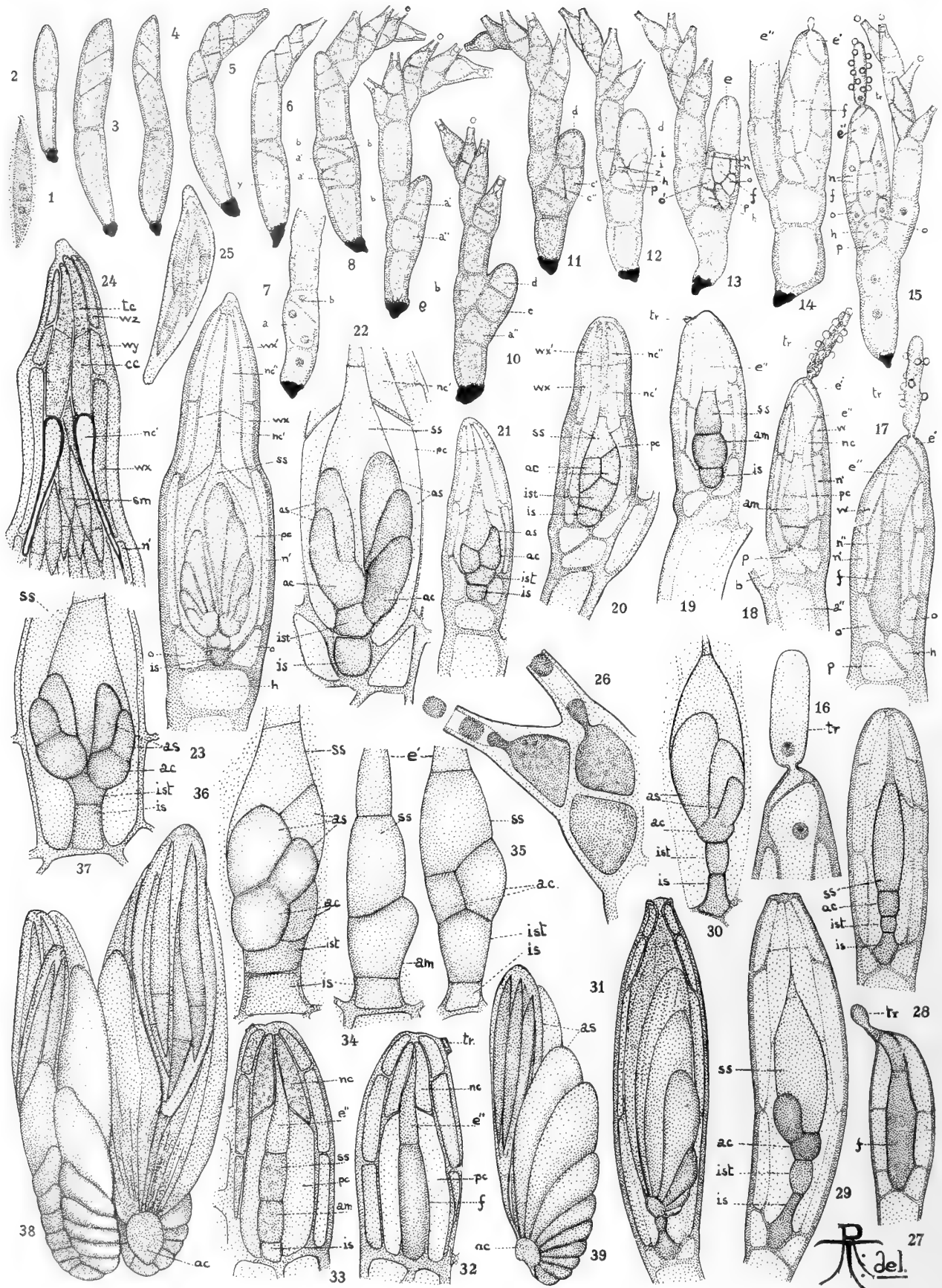
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DESCRIPTIONS OF THE PLATES.

NOTE. — The following figures have been reproduced, by photo-lithography and the heliotype process, from ink drawings made with a camera lucida, and have been slightly reduced from the originals. The letters and numbers following the descriptions of the figures indicate the combinations of Zeiss objectives and eye-pieces used in each case.

DESCRIPTION OF PLATE I.

Stigmatomyces Baeri Peyritsch.

Figs. 1 to 15. Successive stages from the spore to the formation of the mature female organ. See p. 218. All J 2.

Fig. 16. Terminal portion of young perithecium, showing nucleated trichogyne and trichophoric cell before fertilization. J 4.

Fig. 17. Young perithecium in which fertilization has just been accomplished. J 2.

Figs. 18, 19. Young perithecium after fertilization. The first divisions of the carpogenic cell have taken place. J 2.

Fig. 20. A more advanced condition in which the ascogonium has divided into four ascogenic cells (**ac**) and a secondary inferior supporting cell (**ist**). J 2.

Fig. 21. A somewhat more advanced condition of the same. J 2.

Fig. 22. A more advanced condition in which the asci have begun to bud from the ascogenic cells. A slightly oblique lateral view. J 2.

Fig. 23. A still more advanced condition showing the further development of the perithecial cells and their relations to the ascogenic and supporting cells. An optical section seen antero-posteriorly. J 2.

Fig. 24. Terminal portion of a mature perithecium just before the first spore discharge. The upper and lower series of canal cells (**tc** and **c**) are still intact, the latter beginning to be pressed apart by the spore mass (**sm**). The inferior canal-cells (**nc**) have become somewhat modified through the thickening of their walls, and form a diaphragm between the general cavity of the perithecium and that of the neck. J 2.

Fig. 25. A single four-spored ascus isolated. J 2.

Fig. 26. Terminal portion of an appendage showing two antheridial cells with antherozoids both mature and in process of formation. J 12.

Peyritschella geminata Thaxter.

Fig. 27. Young perithecium, in which the trichogyne has not been fertilized. $\frac{1}{2}$ 4.

Fig. 28. Young perithecium after fertilization in which the carpogenic cell has divided into the inferior and superior supporting cells while the ascogonium has divided into a single ascogenic cell (**ac**) and a secondary inferior supporting cell (**ist**). $\frac{1}{2}$ 4.

Figs. 29, 30. More mature condition in which the asci have begun to bud from the ascogenic cell. $\frac{1}{2}$ 4.

Fig. 31. Mature perithecium showing the ascogenic cell and the mass of asci developed from it still supported by the two inferior supporting cells, which will soon be wholly destroyed, leaving the ascus mass free within the cavity of the perithecium. $\frac{1}{2}$ 2.

Laboulbenia elongata Thaxter.

Fig. 32. Young perithecium after fertilization, the insertion only of the trichogyne being visible (**tr**). The carpogenic cell (**f**) has not yet divided. $\frac{1}{2}$ 2.

Fig. 33. The carpogenic cell has divided into the inferior and superior supporting cells and the ascogonium. $\frac{1}{2}$ 2.

Fig. 34. The ascogenic apparatus seen at a stage slightly more advanced than in the previous figure. The ascogonium has begun to grow upward on the right before the formation of septa. J 4.

Fig. 35. Ascogenic apparatus in which the ascogonium has divided into two ascogenic cells (**ac**) and a secondary inferior supporting cell (**ist**). J 4.

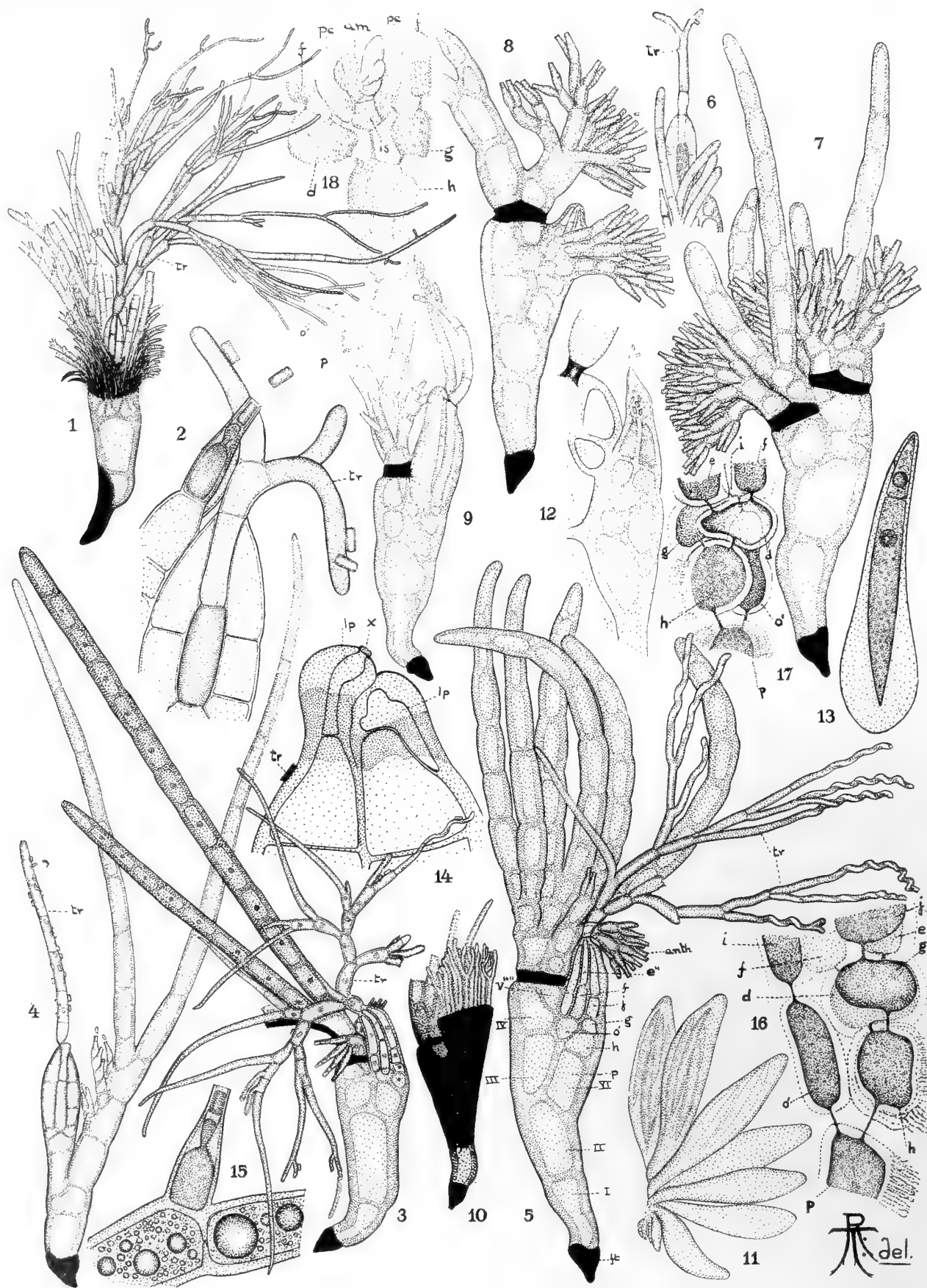
Fig. 36. A more advanced stage, in which the asci (**as**) have begun to bud from the ascogenic cells. J 4. Figs. 32-36 represent lateral views.

Fig. 37. Antero-posterior view of the ascogenic apparatus, showing the two ascogenic cells lying side by side and beginning to separate while the asci have already begun to bud. D 12.

Fig. 38. Two ascogenic cells with asci attached seen as they lie free within the cavity of the perithecium. That at the left seen dorsally, that at the right ventrally. J 2.

Fig. 39. Ascogenic cell with attached asci seen sidewise as it lies free within the cavity of the perithecium. J 2.

A detailed description of the figures on this plate will be found on pages 218-228 of the text. The letters correspond in all the figures, and the corresponding structures are as follows: (**c**) primordial cell of perithecium proper; (**d**) primordial cell of procarpe; (**o**, **o'**) basal cells of perithecium; (**i**, **i**, **z**) primordial cells of perithecial wall-cells, the parietal, and the canal-cells; (**f**) carpogenic cell; (**e''**) trichophoric cell; (**e'**) base of trichogyne (**tr**); (**nc'**, **w**, **wx**, **wy**, **wz**) wall-cells of the perithecium; (**wz**) lip-cells; (**pc**) parietal cells of perithecium; (**nc'**, **cc**, **tc**) canal-cells of perithecium; (**p**) stalk-cell of perithecium; (**h**) secondary stalk-cell; (**o'**) posterior basal cell; (**o**) one of two anterior basal cells; (**nn**) primordial wall-cells; (**am**) ascogonium; (**is**) inferior supporting cell; (**ss**) superior supporting cell; (**ist**) secondary inferior supporting cell; (**ac**) ascogenic cells; (**as**) asci; (**sm**) ascus mass.



THAXTER—MONOGRAPH OF LABOULBENIACEÆ.

DESCRIPTION OF PLATE II.

Teratomyces mirificus Thaxter.

Fig. 1. Young individual. A young perithecium in the centre bears terminally a highly developed branching trichogyne. D 2.

Laboulbenia cristata Thaxter.

Fig. 2. Young perithecium with antheridia above at the right. The darker axile cell the carpogonium, above it the trichophoric cell terminated by the trichogyne, on which are several antherozoids. Leitz oil $\frac{1}{2}$ 4.

Fig. 3. Young individual with much more highly developed trichogyne, many of the cells of which are distinctly nucleated. The cells of the dark rigid appendages at the left also nucleated. D 2.

Rhadinomyces pallidus Thaxter.

Fig. 4. Young individual with simple trichogyne, on which are numerous antherozoids. D 4.

Laboulbenia elongata Thaxter.

Fig. 5. Young individual with well-developed trichogyne, the tips of which are spirally twisted. A fertile branch bearing numerous antheridia projects across the basal cell of the trichogyne. D 2.

Rhachomyces lasiophorus Thaxter.

Fig. 6. Young perithecium with branched trichogyne; at its base several young sterile appendages, and at the left an antheridium. D 4.

Laboulbenia elongata Thaxter.

Fig. 7. Abnormal form on which no perithecium has developed, but in its place the usual blackened insertion-cell bearing sterile and fertile appendages, the latter with great numbers of antheridia. D 2.

Fig. 8. Abnormal form in which the perithecium at the right has not developed, the cells at its base having sent out branches on which are numerous antheridia. D 2.

Laboulbenia paupercula Thaxter.

Fig. 9. Abnormal form in which the ascogenic cells have not developed, while the cells at the base of the perithecium have sent up within it sterile branches, the tips of which project through the terminal pore. D 2.

Laboulbenia parvula Thaxter.

Fig. 10. Specimen in which the perithecium has been broken off while the cells at its base have sent up within it numerous sterile branches. D 2.

Dichomyces princeps Thaxter.

Fig. 11. Group of asci isolated by crushing. The three terminal asci show ascospores within and all are adherent to the remains of the ascogenic cell. Leitz $\frac{1}{2}$ 2.

Peyritschiella curvata Thaxter.

Fig. 12. Antheridium at the right, showing terminal pointed slightly inflated receptacle into which the antherozoids are discharged from the cells just below it. Leitz oil $\frac{1}{2}$ 4.

Laboulbenia elongata Thaxter.

Fig. 13. Spore showing nuclei. $\frac{1}{2}$ 2.

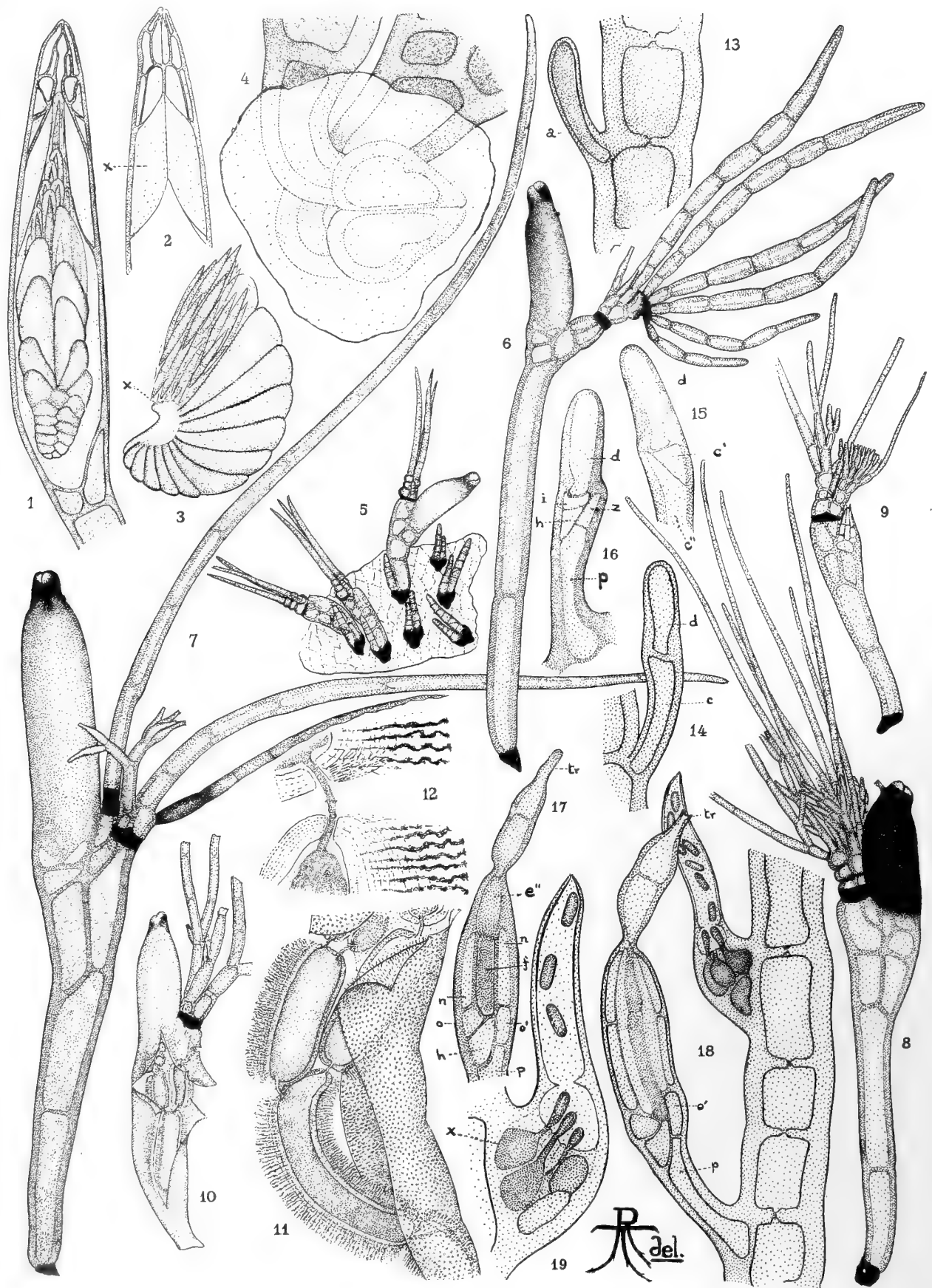
Fig. 14. Terminal portion of perithecium showing structure of lip-cells (**lp**), insertion of trichogyne (**tr**), and "valve" of posterior lip-cell (**x**). $\frac{1}{2}$ 4.

Fig. 15. Portion of fertile branch bearing an antheridium, its structure shown in optical section. $\frac{1}{2}$ 4.

Fig. 16. Protoplasmic connections of the "stalk-cell" and basal cells of the perithecium indicating the successive origin of each. Drawn from a specimen in which the cells had been treated with potash and stained with eosin. The appendage lies at the left. J 2.

Fig. 17. A specimen similarly treated and viewed from the opposite side. The appendage lies at the right. In both figures the stalk-cell is marked (**p**), the posterior basal cell (**o'**), the secondary stalk-cell (**h**), the anterior basal cells, left (**g**), right (**d**), and the four basal wall-cells of the perithecium (**e**, **i**, **f**, **j**), the cell (**j**) not being visible in fig. 17. J 2.

Fig. 18. A specimen similarly treated, slightly crushed so as to separate the basal cells without destroying the ascus mass and the inferior supporting cell, the protoplasmic connection of which with the secondary stalk-cell (**h**) is unbroken, as well as the connections of the two anterior basal cells with the parietal (**pc**) and wall (**f**, **j**) cells above them. The protoplasmic portions only of these cells are indicated, the lettering corresponding to that of the two previous figures, except that (**is**) represents the inferior supporting cell of the ascus apparatus, (**am**) the ascus mass and ascogenic cells, and (**pc**) the parietal cells of the perithecium.



THAXTER-MONOGRAPH OF LABOULBENIACEÆ.

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DESCRIPTION OF PLATE III.

Sphaleromyces Lathrobii Thaxter.

Fig. 1. Mature perithecium seen in optical section, showing dorsal view, the ascogenic cell with attached asci lying free in the cavity of the perithecium. The ascogenic cell itself lies on the opposite side, and is not seen in the figure. $\frac{1}{12}$ 2.

Fig. 2. Terminal portion of a somewhat younger perithecium seen laterally in optical section. $\frac{1}{12}$ 2.

Rhizomyces ctenophorus Thaxter.

Fig. 3. Ascogenic cell with attached asci showing oblique position of the mass as it lies free in the cavity of the perithecium. Only a small portion of the spore mass is shown, which fills the cavity of the perithecium above the ascogenic cell, the spores being freed through the sloughing off of the asci as they mature from the upper portion of the ascogenic cell (at x), and the absorption of the ascus wall. J 2.

Laboulbenia Hageni Thaxter.

Fig. 4. Portion of the soft integument from the abdomen of a white ant, bearing a pair of individuals, inverted so as to show the attachment of the foot as it appears when viewed from below. J 4.

Laboulbenia inflata Thaxter.

Fig. 5. Portion of the hard chitinous integument from the leg of *Bradycellus*, showing seven pairs of individuals in various stages of development, and illustrating the abortion, characteristic of this species, of one member of the pair. C 2.

Laboulbenia Diopsis Thaxter.

Fig. 6. Mature individual of average dimensions. A 12.

Laboulbenia proliferans Thaxter. var. *liberiana*.

Fig. 7. Mature individual of the Liberian variety, the proliferous appendage having the black indurated base. A 12.

Laboulbenia Aspidoglossæ Thaxter.

Figs. 8, 9. Mature and young individuals. A 12.

Laboulbenia elongata Thaxter.

Fig. 10. Individual treated with potash, showing the general envelope ruptured by longitudinal and transverse slits exposing the cells within. A 4.

Fig. 11. Portion of an individual similarly treated. Cells II, III, and VI seen in optical section protruding from the ruptured envelope. The dots on the surface of the latter correspond to the points of attachment of the fibrillæ which arise from the inner layers of the cell-walls on the surfaces next to the envelope. The protoplasmic connection of the different cells is indicated. D 2.

Fig. 12. The adjacent ends of cells III and IV from an individual similarly treated, showing fibrillæ and protoplasmic connection. $\frac{1}{12}$ 12.

Enarthromyces indicus Thaxter.

Fig. 13. Portion of the axis of the receptacle, showing the bud (a) from which the perithecium and its stalk-cell are formed. D 4.

Fig. 14. The bud (a) of the previous figure has become divided by a transverse partition into two superposed cells (c and d). D 4.

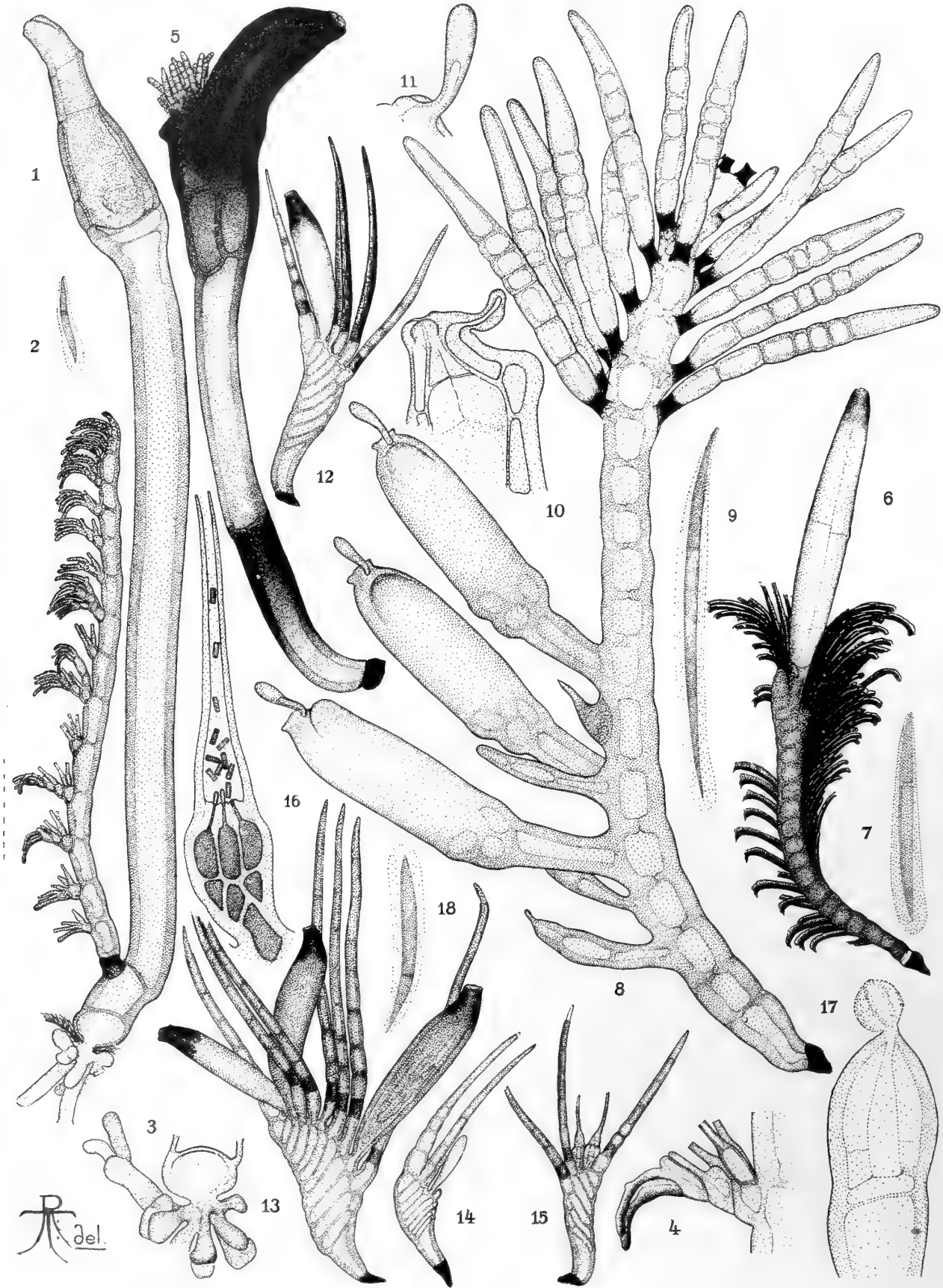
Fig. 15. The cell (c) of the previous figure has become divided into a lower cell (c''), the stalk-cell, and an upper cell (c'), the primordial cell of the perithecium, the cell (d) being the primordial cell of the procarpe. D 4.

Fig. 16. The cell (c') has divided into four cells, which are beginning to grow up around the base of (d). D 4.

Fig. 17. A more advanced stage. The cells (i, i) of the previous figure are divided by transverse septa and have grown up around the base of the cell (d), which has now developed into a mature procarpe, (f) the carpogenic cell, (e'') the tricophoric cell, (tr) the trichogyne, the narrow tip of which is alone receptive. $\frac{1}{12}$ 2.

Fig. 18. Portion of the axis of a receptacle showing relative position of the young perithecium and of the antheridium. The receptive tip of the trichogyne has collapsed, fertilization having presumably been accomplished. $\frac{1}{12}$ 2.

Fig. 19. Antheridium seen in optical section showing antherozoids mature in its cavity and in process of formation from its antheridial cells. $\frac{1}{12}$ 4



THAXTER--MONOGRAPH OF LABOULBENIACEÆ.

DESCRIPTION OF PLATE IV.

Rhizomyces ctenophorus Thaxter.

Fig. 1. Mature individual, showing a fragment of the host's integument adherent between the rhizoids and the basal cell. A 12.

Fig. 2. Spore. D 4.

Fig. 3. Rhizoids, but slightly broken, from another individual. D 2.

Fig. 4. Portion of axis of antheridial appendage showing antheridial branch with three antheridia at its base, and sterile terminal branchlets. $\frac{1}{2}$ 2.

Laboulbenia Orectogyri Thaxter.

Fig. 5. Mature individual. A 12.

Rhachomyces arbusculus Thaxter.

Fig. 6. Mature individual. A 12.

Fig. 7. Spore. D 4.

Enarthromyces indicus Thaxter.

Fig. 8. Mature individual with three mature and three aborted perithecia. A 12.

Fig. 9. Spore. D 4.

Fig. 10. Tip of young perithecium, showing cell-structure. D 4.

Fig. 11. Process from one of dorsal lip-cells of mature perithecium. D 4.

Dimeromyces africanus Thaxter.

Figs. 12, 13. Mature female individuals with one and three mature perithecia respectively. A 12.

Fig. 14. Young female individual, showing origin of perithecia and appendages. A 12.

Fig. 15. Mature male individual with two antheridia. A 12.

Fig. 16. Optical section of antheridium, showing mature antherozoids free within the cavity of the antheridium neck and in process of formation from the antheridial cells. $\frac{1}{2}$ 4.

Fig. 17. Young perithecium, showing (remains of ?) trichogyne. $\frac{1}{2}$ 2.

DESCRIPTION OF PLATE V.

Dimorphomyces muticus Thaxter.

Fig. 1. An old female individual in which four new perithecia are developing. One of the two primary perithecia is shown projecting to the left, and within it two fully developed male individuals. Posterior view. D 4.

Fig. 2. Male and female individuals *in situ* on edge of portion of abdominal ring of host. The male at the left; both viewed posteriorly and illustrating the juxtaposition of the sexes at the point of infection. The ascus group shown in left perithecium. D 4.

Fig. 3. Mature female individual with but two perithecia seen in optical section with ascus groups. Anterior view. D 4.

Fig. 4. Young female individual seen sidewise, its posterior face with the sterile terminal cells of the receptacle at the right. Of the two young perithecia the larger bears a terminal branched trichogyne, to which several antherozoids are affixed. D 12.

Fig. 5. Male and female individual developed from the same spore pair at the point of infection. The female at the right has two young perithecia with terminal trichogynes on which are several antherozoids. Posterior views. D 12.

Fig. 6. Young female individual seen sideways. D 12.

Fig. 7. Tip of perithecium. D 12.

Figs. 8 and 9. Two mature male individuals showing discharge of antherozoids. D 12.

Fig. 10. Spore. D 12.

Dimorphomyces denticulatus Thaxter.

Fig. 11. Mature female individual. View in part anterior. D 4.

Fig. 12. Mature female individual seen posteriorly, a third young perithecium projecting at the right. D 4.

Fig. 13. Tip of perithecium. D 12.

Figs. 14 and 15. Two male individuals with antherozoids. D 12.

Fig. 16. Spore. D 12.

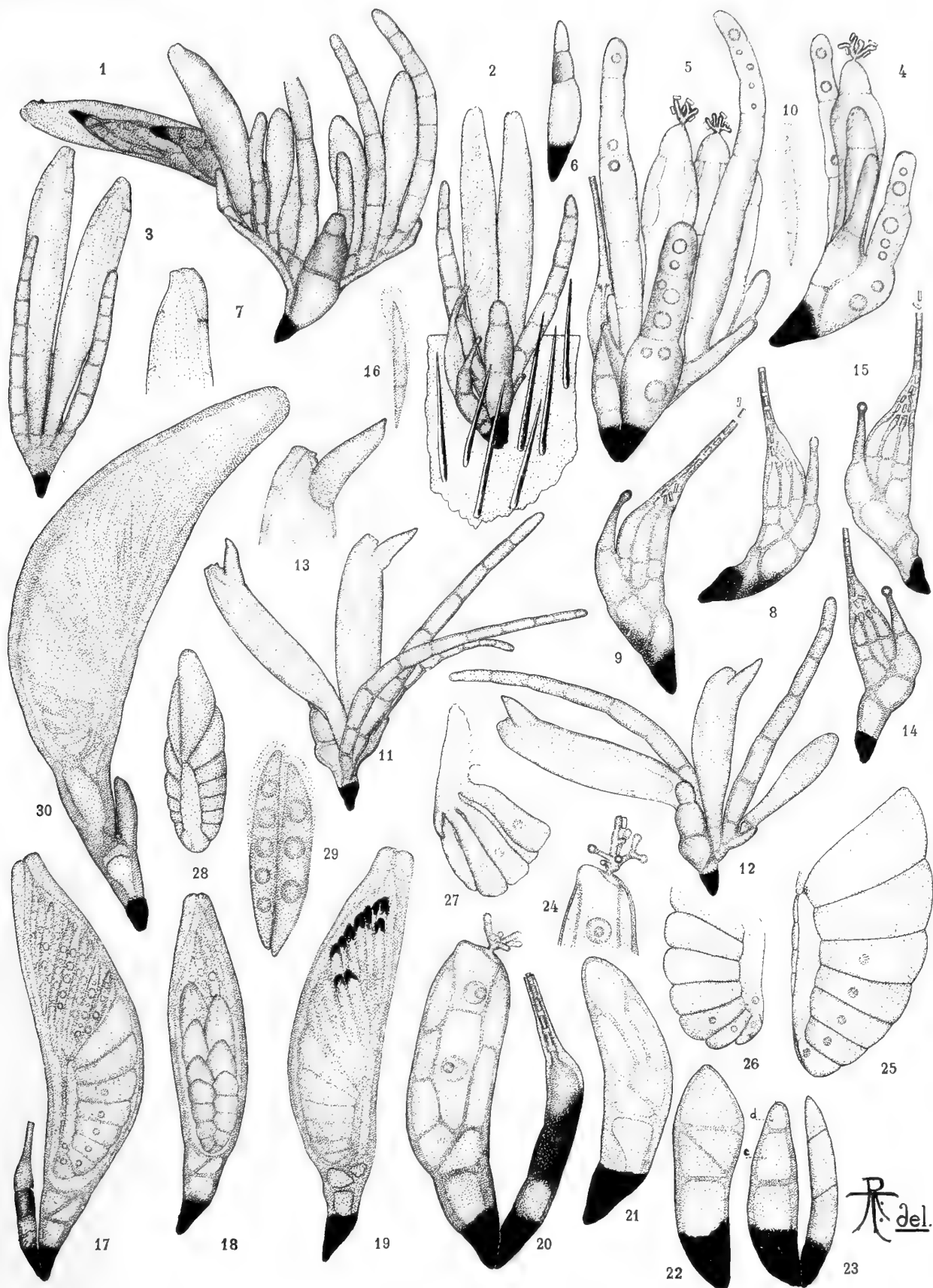
Amorphomyces Falagriæ Thaxter.

Fig. 17. Male and female individual developed from the same spore pair at the point of infection. The perithecium of the female shown in optical section with the nucleated asci arising from the long ascogonic cell at the left. The ascus mass is viewed obliquely sidewise. The spore mass in the terminal portion of the perithecium consists of spore pairs freed through the absorption of the ascus walls. D 4.

Fig. 18. Female individual viewed anteriorly. The asci are shown arising alternately in a double row from the ascogonic cell, which lies behind. D 4.

Fig. 19. Mature female individual viewed sidewise. Many of the spore pairs in the terminal portion have begun to germinate, their blackened haustoria directed upward. D 4.

Fig. 20. Male and female individuals developed from the same spore pair. The female at the left terminated by a branching trichogyne, the carpogonium and trichophoric cell both distinctly nucleolated. The male at the right shows antherozoids before discharge. D 12.



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Fig. 21. Female individual before development of trichogyne. D 12

Fig. 22. Young female individual showing first three septa. D 12.

Fig. 23. Germinating spore pair, the male at the right. D 12.

Fig. 24. Terminal portion of young female individual with branching trichogyne on which is a single antherozoid. D 12.

Fig. 25. Ascus mass, showing origin of asci from ascogenic cell at the left. Leitz oil $\frac{1}{2}$ D.
Figs. 17-25 drawn from living material.

Fig. 26. A view similar to the last, the asci somewhat shrunk by glycerine. $\frac{1}{2}$ D.

Fig. 27. Asci adhering to lower part of ascogenic cell, isolated from perithecium by crushing and treated with glycerine. The asci have been broken from the upper portion. Leitz oil. $\frac{1}{2}$ D.

Fig. 28. Ascus mass with ascogenic cell viewed anteriorly. The view opposite to that seen in fig. 18. D 4.

Fig. 29. Spore pair. The "male spore" at the left is slightly smaller. D 12.

Amorphomyces floridanus Thaxter.

Fig. 30. Mature individual. D 4.

DESCRIPTION OF PLATE VI.

Camptomyces melanopus Thaxter.

- Figs. 1, 2. Mature individuals, posterior and nearly anterior views. D 2.
Fig. 3. Young individual with trichogyne and antherozoids. D 4.
Fig. 4. Young perithecium, showing trichogyne with antherozoids *in situ*, and large central carpogenic cell. D 12.
Figs. 5, 6. Lateral and anterior views of antheridium. D 12.

Peyritschiella geminata Thaxter.

- Fig. 7. Mature individual with two terminal perithecia. D 2.
Fig. 8. Mature individual with single terminal perithecium. D 2.
Fig. 24. Spore. D 4.

Peyritschiella curvata Thaxter.

- Fig. 9. Mature individual with antheridium at the right. D 2.
Fig. 10. Mature individual with antheridium at the left. D 2.
Fig. 11. Germinating spore. D 4.
Figs. 12-15. Successive stages in development. D 4.
Fig. 16. Young individual, the antheridium at the right, the immature perithecium terminated by the small trichogyne. D 4.
Fig. 17. Spore. D 4.
Fig. 18. Perithecium seen in section with contained ascus mass. No spores have been discharged, and the canal-cells of the tip are not yet destroyed. Leitz oil $\frac{1}{2}$ 2.

Peyritschiella minima Thaxter.

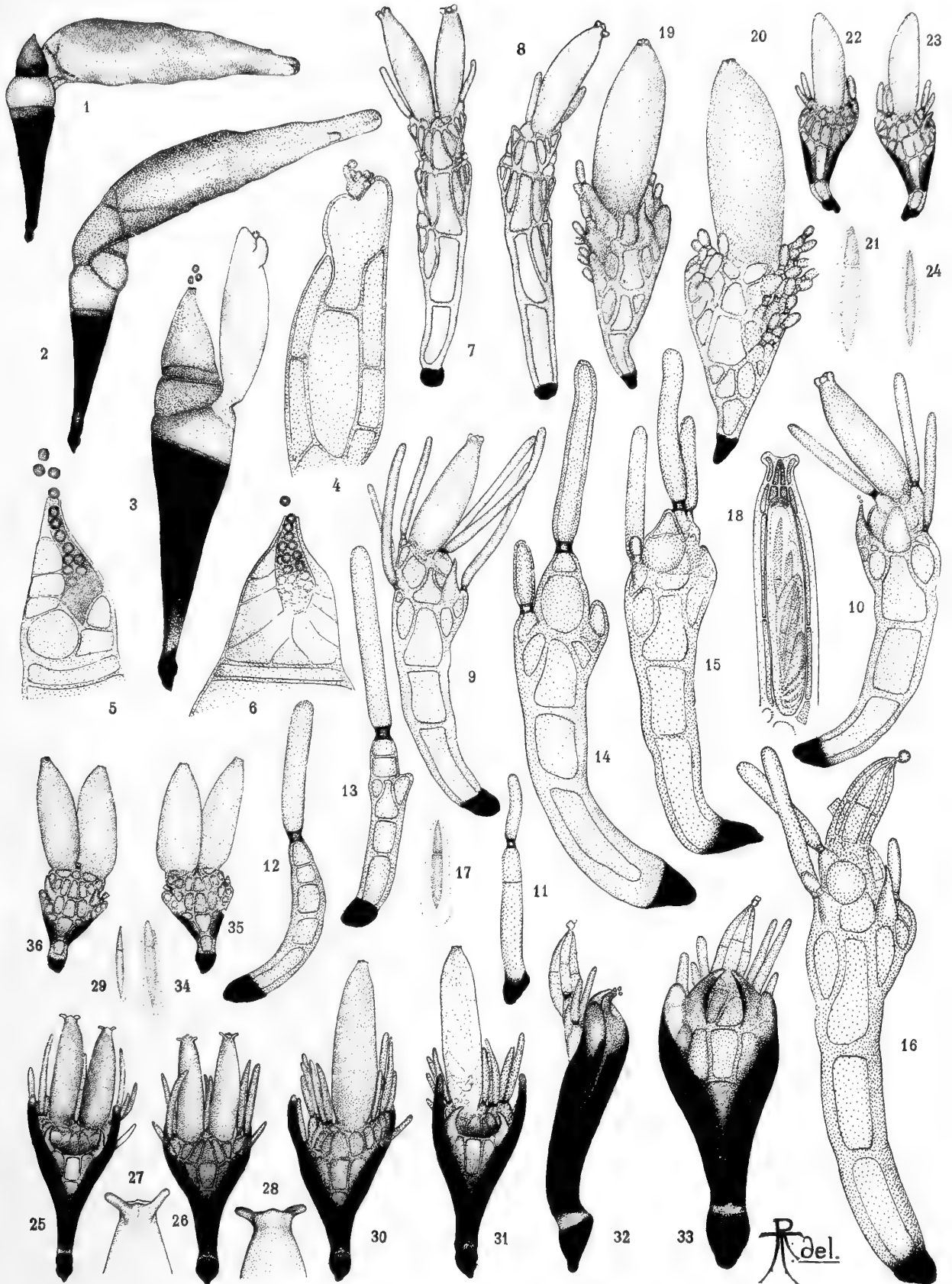
- Figs. 19, 20. Two mature individuals, the antheridium shown (in 19) at the right. D 2.
Fig. 21. *nec del.*

Peyritschiella nigrescens Thaxter.

- Figs. 22, 23. Mature specimen seen from both sides, the antheridium at the right in (23).
Fig. 24. See *sub P. geminata*.

Dichomyces furciferus Thaxter.

- Fig. 25. Mature individual, posterior view, showing antheridia. D 2.
Fig. 26. Mature individual, anterior view. D 2.
Fig. 27. Tip of perithecium, posterior view. D 12.
Fig. 28. Tip of perithecium, anterior view. D 12.
Fig. 29. Spore. D 4.



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Dichomyces inæqualis Thaxter.

- Fig. 30. Mature individual, anterior view. D 2.
 Fig. 31. Mature individual, posterior view, showing antheridia. D 2.
 Fig. 32. Young individual, seen laterally; antheridium at the right discharging antherozoids;
 the young perithecium terminated by a small trichogyne, on which is a single antherozoid. D 4.
 Fig. 33. The same, posterior view. D 4.
 Fig. 34. Spore. D 4.

Dichomyces infectus Thaxter.

- Figs. 35, 36. Anterior and posterior view of the same specimen. D 2.

DESCRIPTION OF PLATE VII.

Haplomyces californicus Thaxter.

- Figs. 1, 2. Mature individuals. D 2.
Fig. 3. Antheridium enlarged. D 4.
Fig. 4. Spore. D 4.

Haplomyces texanus Thaxter.

- Fig. 5. Nearly mature individual with hyaline receptacle. D 2.
Fig. 6. Mature individual. The sub-basal cell of the receptacle and the basal cell of the antheridium deeply blackened. D 2. Fig. 2a. Spore.

Haplomyces virginianus Thaxter.

- Figs. 7 and 8. Two mature individuals. D 2.
Fig. 9. Antheridium enlarged. D 12.
Fig. 10. Spore. D 4.

Cantharomyces pusillus Thaxter.

- Fig. 11. Immature individual, the base of the trichogyne still adherent near the tip on the inner side. D 4.
Figs. 12, 13. Two mature individuals, with simple and branched appendage. D 2.
Fig. 14. Two spores. D 4.

Cantharomyces occidentalis Thaxter.

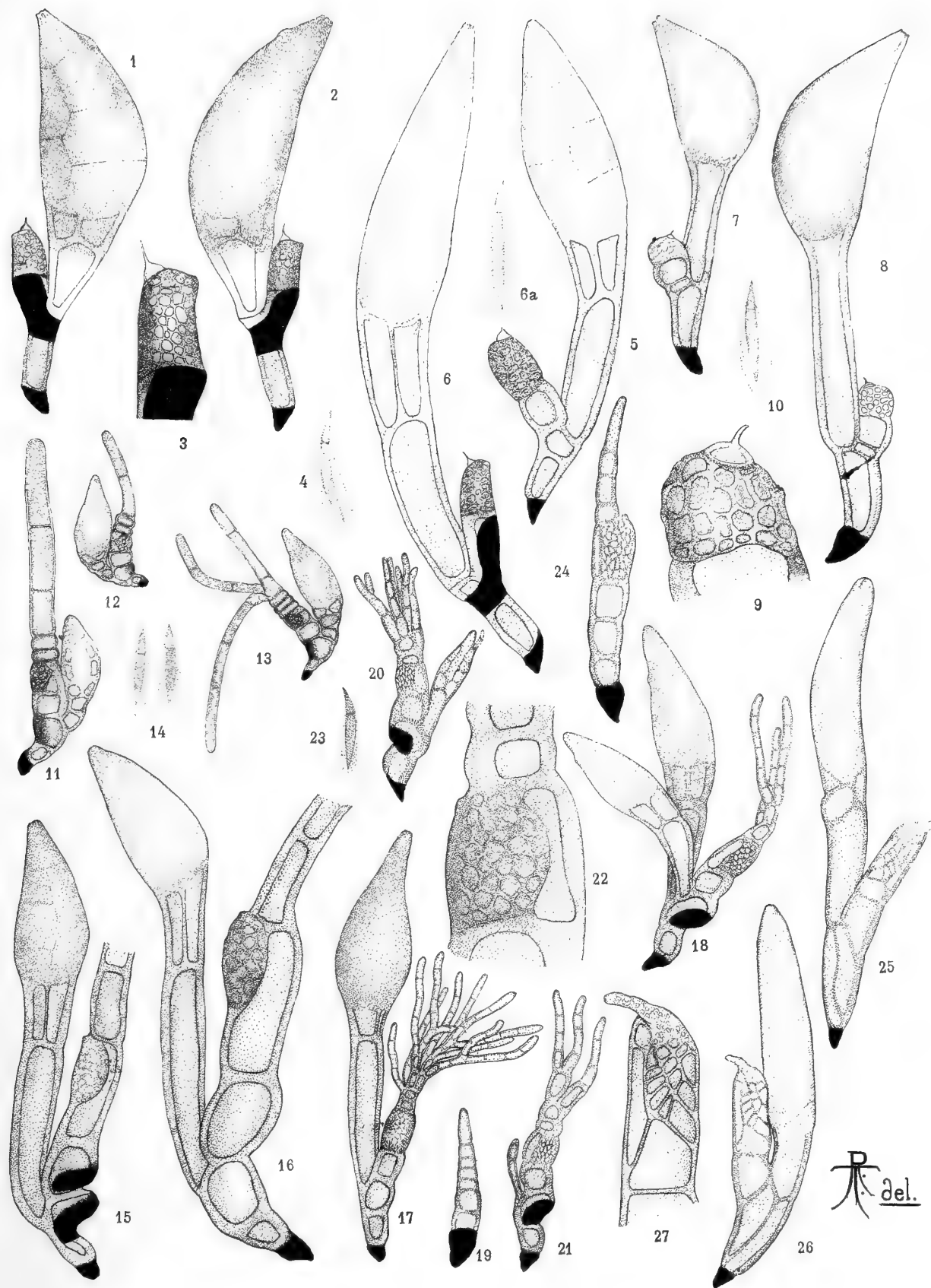
- Figs. 15, 16. Two mature individuals: the tips of the appendages broken. D 2.

Cantharomyces Bledii Thaxter.

- Fig. 17. Mature individual. D 2.
Fig. 18. Mature individual, the sub-basal cell of receptacle partly blackened and producing two perithecia. D 2.
Fig. 19. Germinating spore. D 4.
Fig. 20. Young individual, with remains of trichogyne. D 4.
Fig. 21. Young individual: the immature perithecium consisting of two superposed cells projecting at the left. D 4.
Fig. 22. Antheridium enlarged. D 12.
Fig. 23. Spore. D 4.
Fig. 24. Young individual from which the perithecium has not yet begun to develop. D 4.

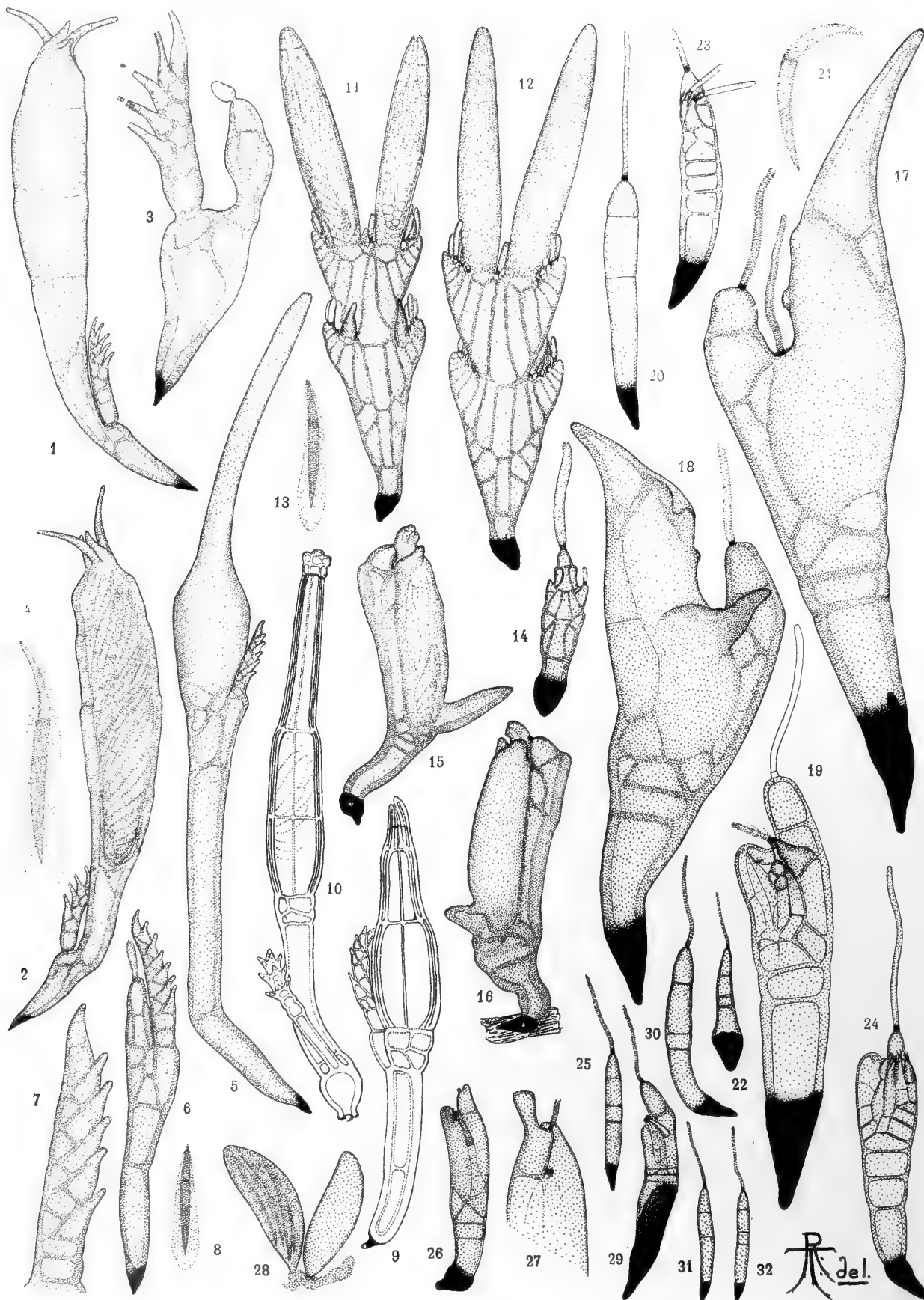
Eucantharomyces Atrani Thaxter.

- Fig. 25. Nearly mature individual (the tip of the antheridium supplied). D 2.
Fig. 26. Younger individual. D 2.
Fig. 27. Antheridium enlarged. D 4.



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DESCRIPTION OF PLATE VIII.

Stigmatomyces virescens Thaxter.

Figs. 1, 2. Two mature individuals (2) showing spore and ascus mass. A 12.

Fig. 3. Young individual, the antheridium with discharged antherozoids at the left; the young perithecium with terminal trichogyne at the right. D 4.

Fig. 4. Spore. D 4.

Stigmatomyces entomophilus (Peck) Thaxter.

Fig. 5. Mature individual. A 12.

Fig. 6. Young individual with antheridium at the right and young perithecium with terminal trichogyne at the left. D 4.

Fig. 7. Antheridium enlarged. D 12.

Fig. 8. Spore. D 4.

Stigmatomyces Baeri (Knoch) Peyritsch.

Fig. 9. Mature individual (after Peyritsch).

Helminthophana Nycteribiae Peyritsch.

Fig. 10. Mature individual (after Peyritsch).

Dichomyces princeps Thaxter.

Fig. 11. Mature individual, posterior view. D 2.

Fig. 12. Mature individual, anterior view. D 12.

Fig. 13. Spore. D 4.

Fig. 14. Young individual.

Chitonomyces spinigerus Thaxter.

Figs. 15, 16. Two mature individuals. D 2.

Chitonomyces paradoxus Peyritsch.

Figs. 17, 18. Two individuals seen from opposite sides. D 2.

Fig. 19. Young individual seen in optical section. The ascogenic cell has divided into three parts, and seems to be connected with the base of a trichogyne (?) The perithecium has begun to grow out laterally at the left. $\frac{1}{2}$ 2.

Fig. 20. Young individual, showing first cell divisions. D 4.

Fig. 21. Spore. D 4.

Hydræomyces Halipli Thaxter.

Fig. 22. Young individual, showing first divisions. D 4.

Fig. 23. Young individual in which the lower appendages have developed. D 4.

Fig. 24. Young individual, the three lower appendages with their basal cells at the right; at the left the young perithecium, and between them the ascogenic cell and trichophoric cell. Leitz oil $\frac{1}{2}$ 2.

Chitonomyces marginatus Thaxter.

Fig. 25. Young individual, showing first divisions. D 4.

Fig. 26. Young individual in which the terminal cell of the receptacle has just begun to proliferate. D 4.

Fig. 27. Terminal portion of young individual in which the proliferation is completed without having become blackened. D 12.

Fig. 28. Asci with ascospores. D 12.

Chitonomyces affinis Thaxter.

Figs. 29, 30. Young individuals. D 4.

Chitonomyces minor Thaxter.

Figs. 31, 32. Young individuals, showing first divisions. D 4.



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DESCRIPTION OF PLATE IX.

Corethromyces Cryptobii Thaxter.

Fig. 1. Mature individual. The inner main appendage broken off at its base, the secondary appendages more or less broken. A 12.

Fig. 2. Young individual slightly crushed to show three main appendages with young perithecium terminated by remains of a branched trichogyne. A 12.

Corethromyces jacobinus Thaxter.

Fig. 3. Mature individual. A 12.

Fig. 4. Immature individual, showing position of antheridial branches. A 12.

Fig. 5. Single antheridial branch with two discharged antherozoids. D 12.

Corethromyces setigerus Thaxter.

Fig. 6. Nearly mature individual. The tips of the appendages are broken off. A 12.

Rhadinomyces pallidus Thaxter.

Fig. 7. Mature individual, developing a second perithecium. A 12.

Fig. 8. Mature individual of typical form. A 12.

Fig. 9. Antheridial branch. D 12.

Fig. 10. Mature individual of larger form (var. a), the branches mostly sterile. A 12.

Fig. 11. Spore of fig. 10. D 4.

Rhadinomyces cristatus Thaxter.

Fig. 12. Mature individual with two perithecia, one immature. A 12.

Fig. 13. Terminal portion of mature perithecium seen in optical section, the canal-cells having been destroyed. $\frac{1}{2}$ 4.

Fig. 14. Antheridial branch with discharged antherozoids. D 12.

Fig. 15. Spore. D 4.

Idiomycetes Peyritschii Thaxter.

Fig. 16. Mature individual with two perithecia, the appendages all broken from the right side. A 12.

Fig. 17. Mature individual seen from opposite side. A 12.

Fig. 18. Antheridial appendage viewed laterally. D 4.

Fig. 19. Antheridial appendage; face view, showing three rows of antheridia. D 4.

Fig. 20. Sterile appendage. D 4.

Fig. 21. Spore. D 4.

Rhadinomyces cristatus Thaxter.

Fig. 22. Young individual, showing spinous process at base of primary appendage. D 4.

Fig. 23. Antheridial branchlet of three superposed antheridia, showing structure in optical section. $\frac{1}{2}$ 4.

DESCRIPTION OF PLATE X.

Teratomyces brevicaulis Thaxter.

- Fig. 1. Mature individual with three perithecia. A 12.
Fig. 2. Single appendage. D 4.
Fig. 3. Spore. D 4.

Teratomyces mirabilis Thaxter.

- Fig. 4. Mature individual with two perithecia, one immature. A 12.
Fig. 5. Single appendage from mature individual. The antheridia and lateral branches have been broken off towards its base. D 4.
Fig. 6. Young appendage bearing a row of antheridia at the left. D 4.
Fig. 7. Spore. D 2.

Teratomyces Quedianus Thaxter.

- Fig. 8. Mature individual.

Teratomyces Actobii Thaxter.

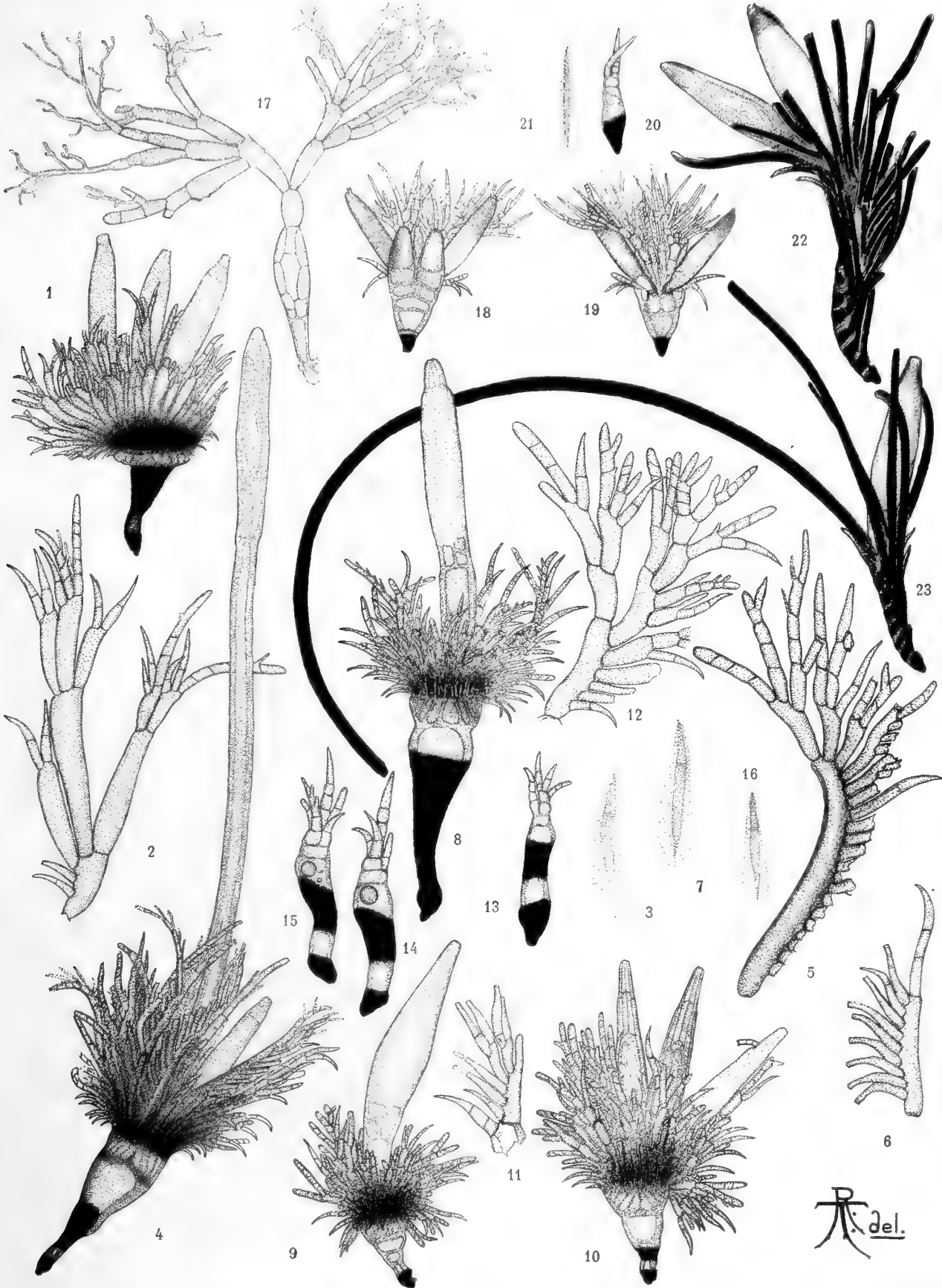
- Fig. 9. Mature individual. A 12.
Fig. 10. Individual not quite mature with three perithecia. The base of the trichogyne still adherent to that on the right, the two at the left seen in optical section before any spores have been discharged. A 12.
Fig. 11. Appendage with antheridia and two discharged antherozoids. D 4.
Fig. 12. Mature appendage. Two old antheridia near the base. D 4.
Figs. 13-15. Young individuals in various stages of development. D 4.
Fig. 16. Spore. D 4.
Fig. 17. Trichogyne and young perithecium seen in optical section. D 4.

Diplomyces Actobianus Thaxter.

- Figs. 18, 19. Mature individuals, posterior and anterior views. A 12.
Fig. 20. Young individual. D 4.
Fig. 21. Spore. D 4.

Rhachomyces Lathrobii Thaxter.

- Fig. 22. Mature individual with two perithecia. The receptacle has apparently become pro-liferous through the abortion of the first perithecium. The longer appendages are broken. A 12.
Fig. 23. Mature individual of typical form. A 12.



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DESCRIPTION OF PLATE XI.

Sphaleromyces occidentalis Thaxter.

Fig. 1. Mature individual. A 12.

Sphaleromyces Lathrobii Thaxter.

Figs. 2, 3. Mature individuals. A 12.

Fig. 4. Younger individual, more highly magnified. D 4.

Fig. 5. Spore. D 4.

Fig. 19. Terminal portion of appendage of a young individual, showing three antheridia and spinous process. $\frac{1}{12}$ 4.

Compsomyces verticillatus Thaxter.

Fig. 6. Mature individual: the two basal cells unusually elongate, the branch from the stalk of the perithecium somewhat abnormal. A 12.

Fig. 7. Mature individual, normal form. A 12.

Fig. 8. Mature individual developing a second perithecium at the right. A 12.

Fig. 9. Young individual, showing young perithecium and its very highly developed spirally twisted trichogyne. A 12.

Fig. 10. A young perithecium with much less highly developed trichogyne. D 12.

Fig. 11. Perithecium enlarged, showing prominences. D 4.

Fig. 12. Perithecium seen in optical section with contained ascus mass before any spore discharge has occurred. D 4.

Fig. 13. Peculiar modification of basal cell of receptacle. D 4.

Fig. 14. Portion of appendage with lateral antheridia. D 12.

Fig. 15. Two spores. D 4.

Moschomyces insignis Thaxter.

Fig. 16. Mature individual with four perithecia, two of which are shown in optical section with their spore masses, that at the left showing lateral view of ascogenic cell at its base, the other showing the round tips of the numerous asci. The cellular haustorium is shown projecting through a fragment of the soft chitinous integument of the host torn off when the fungus was removed. A 12.

Fig. 17. An ascus with eight ascospores; its stalk partly broken off. Leitz oil $\frac{1}{12}$ 4.

Fig. 18. One of the masses of coherent spores discharged from the perithecium. D 4.

Fig. 19. See above sub *Sphaleromyces Lathrobii*.

Chaetomyces Pinophili Thaxter.

Figs. 20, 21. Two mature individuals. A 12.

Fig. 22. Spore. D 4.

Rhachomyces speluncalis Thaxter.

Fig. 23. Mature individual, the receptacle apparently proliferous. A 12.

Fig. 24. Mature individual typical form. A 12.

Fig. 25. Antheridium. D 4.

Moschomyces insignis Thaxter.

Fig. 26. Portion of fertile appendage with branchlet terminated by an antheridium. J 4.

DESCRIPTION OF PLATE XII.

Rhachomyces furcatus Thaxter.

Fig. 1. Spore. D 4.

Fig. 2. Mature individual: the first perithecium on the left has aborted, and the mature perithecium is borne on a proliferation of the receptacle. A 12.

Fig. 3. Mature individual, normal form. A 12.

Rhachomyces longissimus Thaxter.

Fig. 4. Mature individual. A 12.

Fig. 5. Spore.

Rhachomyces hypogæus Thaxter.

Fig. 6. Mature individual. A 12.

Rhachomyces lasiophorus Thaxter.

Figs. 7, 8. Mature individuals or Atranas, posterior and lateral views. A 12.

Fig. 9. Spore.

Figs. 10, 11. Young individuals, showing first divisions of sub-basal cell. D 4.

Rhachomyces pilosellus (Robin) Thaxter.

Figs. 12, 13. Two mature individuals. A 12.

Fig. 14. Individual with three aborted perithecia, the receptacle twice proliferous. A 12.

Fig. 15. Antheridium? Similar organs are shown in fig. 13, at the right. D 12.

Fig. 16. Spore. D 4.

Rhachomyces lasiophorus Thaxter.

Fig. 17. Mature individual on *Badister micans*. A 12.

Fig. 18. Semi-diagrammatic figure of a pair of antheridia with appendages on either side; posterior view. J 4.

Fig. 19. Position of antheridium seen sidewise, and outlined in part through the appendage which lies beside it. J 4.



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DESCRIPTION OF PLATE XIII.

Laboulbenia vulgaris Peyritsch.

Figs. 1, 2. Two mature individuals. A 12.

Fig. 3. Spore. D 4.

Laboulbenia pedicillata Thaxter.

Fig. 4. Mature individual, short form. A 12.

Fig. 5. Young individual of short form. A 12.

Fig. 6. Spore. D 4.

Fig. 7. Mature individual, elongate form. A 12.

Fig. 8. Young individual of elongate form. A 12.

Laboulbenia subterranea Thaxter.

Figs. 9, 10. Two mature individuals. A 12.

Fig. 11. Spore. D 4.

Laboulbenia truncata Thaxter.

Fig. 12. Mature individual, the tip of the appendage broken. A 12.

Fig. 13. Young individual, showing character of inner and outer appendage. A 12.

Fig. 14. Spore. D 4.

Laboulbenia perpendicularis Thaxter.

Fig. 15. Mature individual, the tip of the outer appendage broken. A 12.

Fig. 16. Inner appendage with single antheridium at left. D 12.

Fig. 17. Young individual with unbroken appendages. A 12.

Fig. 18. Spore.

Laboulbenia Nebriæ Peyritsch.

Fig. 19. Mature individual. A 12.

Fig. 20. Young individual with three antheridia on inner appendage. A 12.

Fig. 21. Inner appendage with a single antheridium at the left. A 12.

Laboulbenia Casnoniæ Thaxter.

Fig. 22. Mature individual. A 12.

Fig. 23. Spore. D 4.

Laboulbenia paupercula Thaxter.

Figs. 24, 25. Two individuals in which the inner appendage occupies opposite positions in either case. A 12.

Fig. 26. Branch of inner appendage with two antheridia. D 12.

Fig. 27. Spore. D 4.

Laboulbenia cornuta Thaxter.

Fig. 28. Mature individual, the appendages broken. A 12.

Fig. 29. Young individual. A 12.

Fig. 30. Tip of perithecium, showing appendage formed by the outgrowth of one of the lip-cells. A 12.

DESCRIPTION OF PLATE XIV.

Laboulbenia compressa Thaxter.

- Fig. 1. Mature individual. A 12.
Fig. 2. Spore. D 4.
Fig. 11. Portion of branch from inner appendage with two antheridia. D 12.

Laboulbenia elegans Thaxter.

- Fig. 3. Mature individual. A 12.
Fig. 4. Tip of perithecium. D 4.
Fig. 5. Branch of inner appendage with two antheridia. D 12.
Fig. 6. Spore. D 4.

Laboulbenia lepida Thaxter.

- Fig. 7. Mature individual. A 12.
Fig. 8. Tip of perithecium. D 4.
Fig. 9. Branch from inner appendage with three antheridia. D 12.
Fig. 10. Spore. D 4.

Laboulbenia conferta Thaxter.

- Fig. 12. Mature individual. A 12.
Fig. 13. Branch of inner appendage with two antheridia. D 12.
Fig. 14. Spore. D 4.

Laboulbenia Harpali Thaxter.

- Figs. 15, 16. Two mature individuals.
Fig. 17. Branch of inner appendage with single antheridium. D 12.
Fig. 18. Spore. D 4.

Laboulbenia filifera Thaxter.

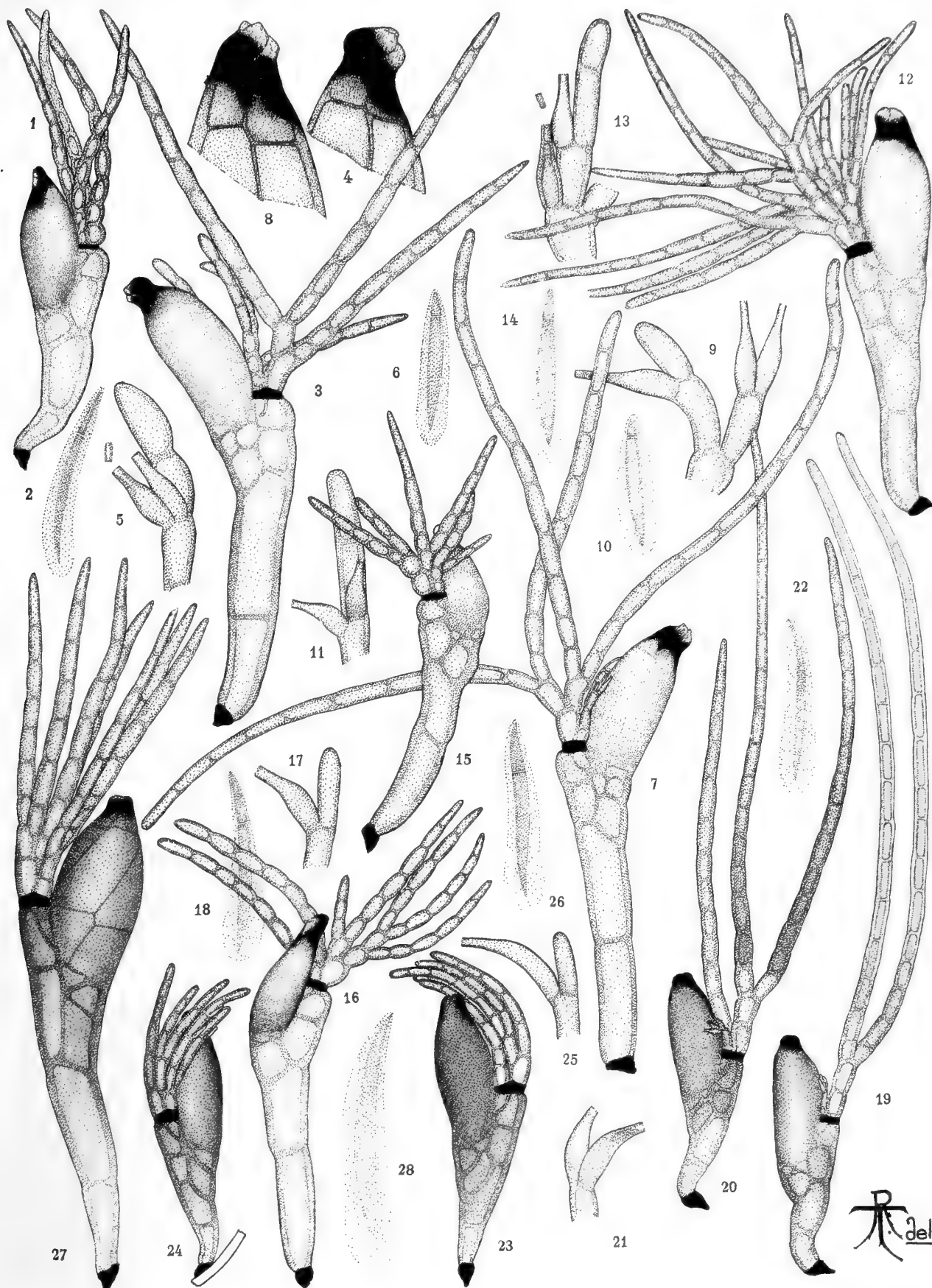
- Figs. 19, 20. Mature individuals. A 12.
Fig. 21. Inner appendage with two antheridia. D 12.
Fig. 22. Spore. D 4.

Laboulbenia scelophila Thaxter.

- Figs. 23, 24. Two mature individuals. A 12.
Fig. 25. Tip of branch from inner appendage with single antherozoid. D 12.
Fig. 26. Spore. D 4.

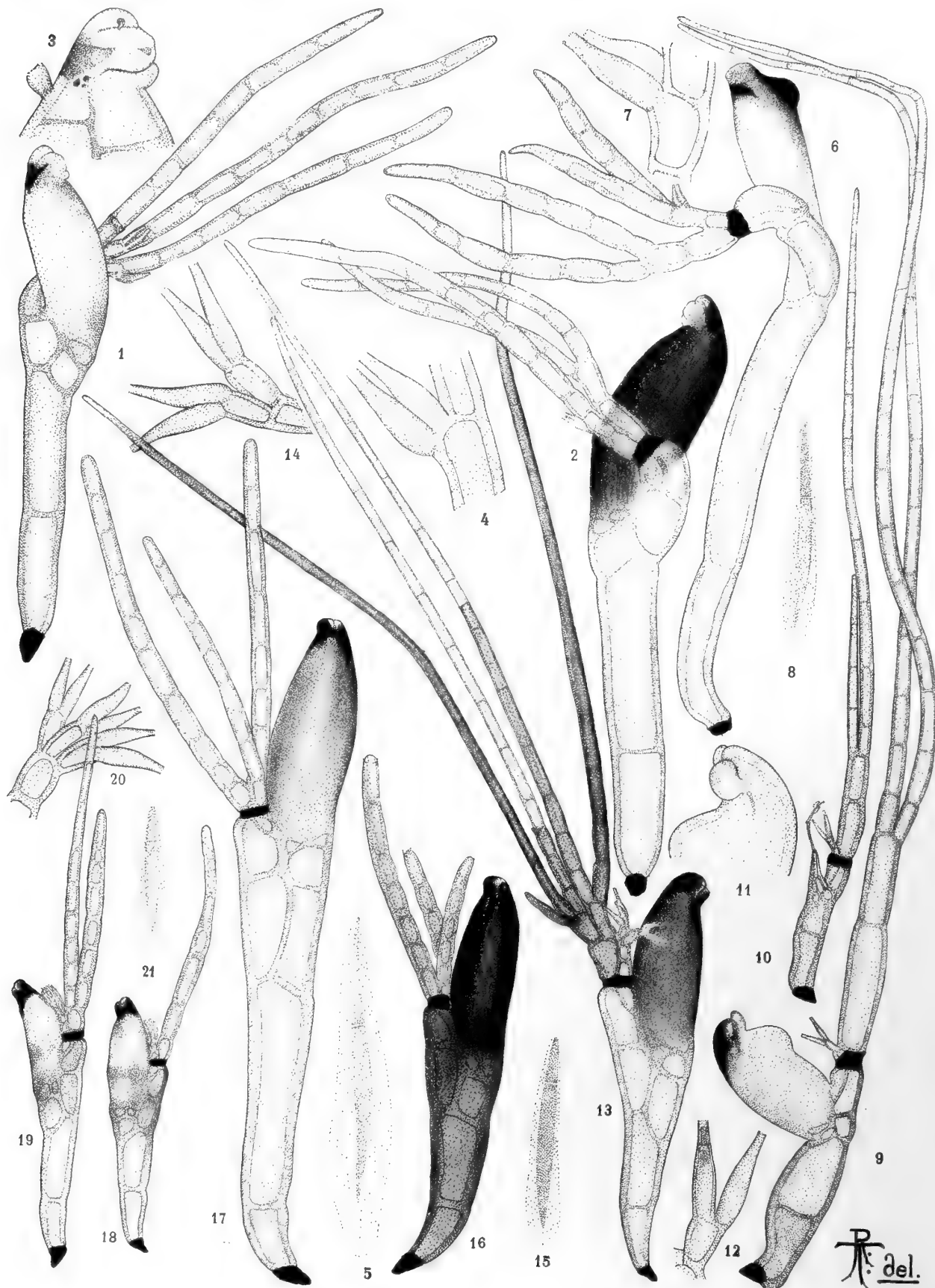
Laboulbenia recta Thaxter.

- Fig. 27. Mature individual. A 12.
Fig. 28. Spore. D 4.



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DESCRIPTION OF PLATE XV.

Laboulbenia contorta Thaxter.

- Figs. 1, 2. Two mature individuals. A 12.
 Fig. 3. Tip of perithecium, the base of the trichogyne still adherent at the left. D 4.
 Fig. 4. Portion of inner appendage with a pair of antheridia. D 12.
 Fig. 5. Spore. D 4.

Laboulbenia gibberosa Thaxter.

- Fig. 6. Mature individual. A 12.
 Fig. 7. Portion of inner appendage with pair of antheridia. D 12.
 Fig. 8. Spore. D 4.

Laboulbenia umbonata Thaxter.

- Fig. 9. Mature individual. A 12.
 Fig. 10. Young individual, showing antheridia and trichogyne with antherozoids *in situ*. A 12.
 Fig. 11. Tip of perithecium, showing ear-like lips. D 4.
 Fig. 12. Inner appendage with two antheridia. D 12.

Laboulbenia terminalis Thaxter.

- Fig. 13. Mature individual. A 12.
 Fig. 14. Branch of inner appendage with four antheridia. D 12.
 Fig. 15. Spore. D 4.

Laboulbenia rigida Thaxter.

- Figs. 16, 17. Mature individuals. A 12.

Laboulbenia polyphaga Thaxter.

- Figs. 18, 19. Two mature individuals. A 12.
 Fig. 20. Branch of inner appendage with six antheridia. D 12.
 Fig. 21. Spore. D 4.

DESCRIPTION OF PLATE XVI.

Laboulbenia elongata Thaxter.

- Figs. 1, 2. Two mature individuals. On *Platynus extensicollis*. A 12.
Fig. 3. Branch of inner appendage with antheridia. D 12.
Fig. 4. Mature individual from *Platynus cincticollis*, typical form. A 2.
Fig. 5. Spore of Fig. 4. D 4.
Fig. 6. Form on *Colpodes purpuripennis*. A 2.
Fig. 7. Spore of Fig. 6. D 4.
Fig. 8. Form on *Platynus floridanus*. A 2.
Fig. 9. Younger individual (see fig. 4) on *Platynus cincticollis*. A 2.
Fig. 10. Form on elytra of *Platynus cincticollis*. A 2.
Fig. 11. Form on *Platynus extensicollis*. A 2.
Fig. 12. Form on *Colpodes duplex*. A 2.
Fig. 13. Form on *Platynus dissectus*. A 2.
Fig. 14. Form from legs of *Platynus cincticollis*. A 2.

Laboulbenia europæa Thaxter.

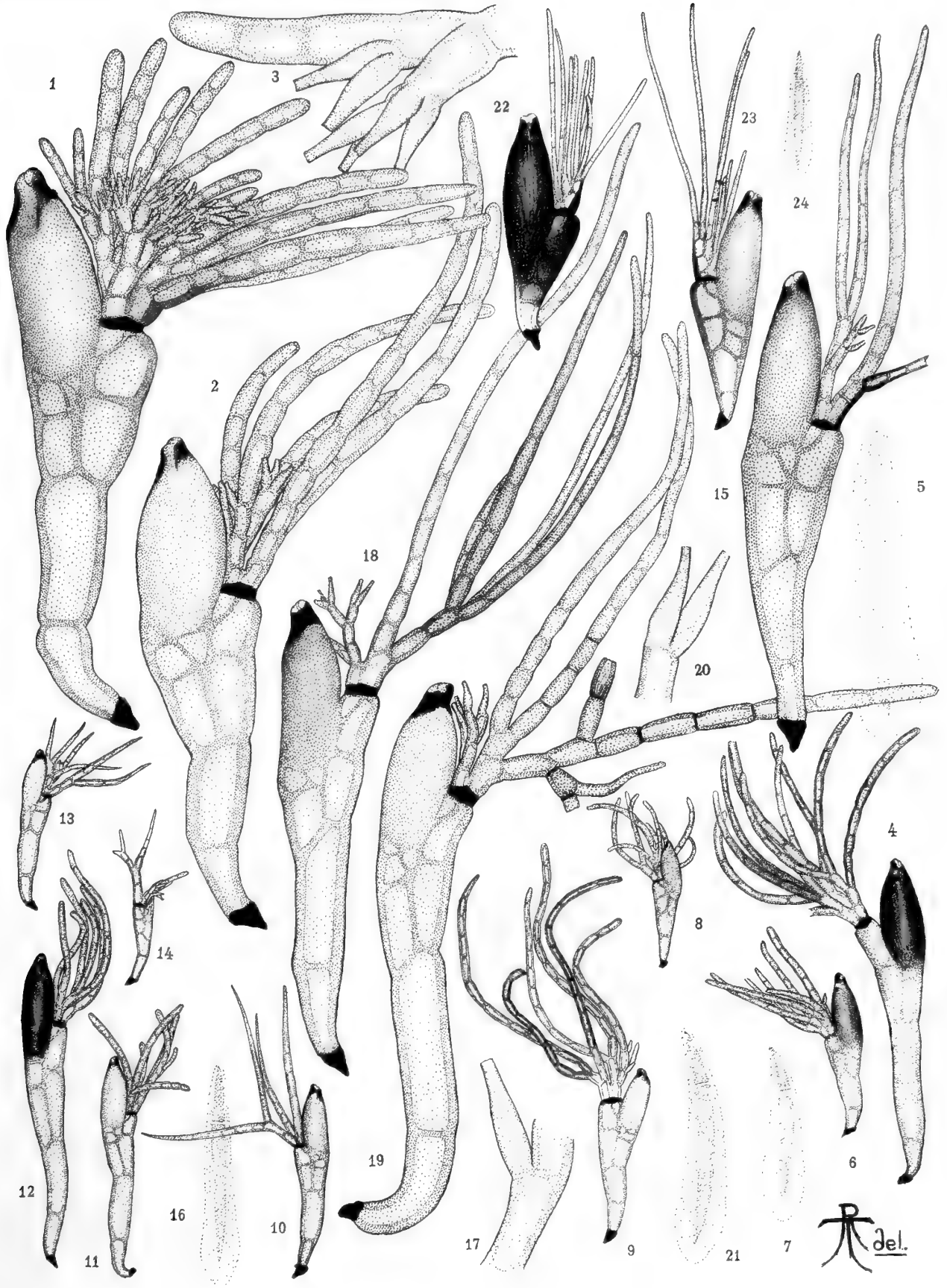
- Fig. 15. Mature individual from *Chlœnius œneocephalus*. A 12.
Fig. 16. Spore. D 4.
Fig. 17. Part of inner appendage with antheridium. D 12.

Laboulbenia Pterostichi Thaxter.

- Figs. 18, 19. Two mature individuals. A 12.
Fig. 20. Branch of inner appendage with two antheridia. D 12.
Fig. 21. Spore. D 4.

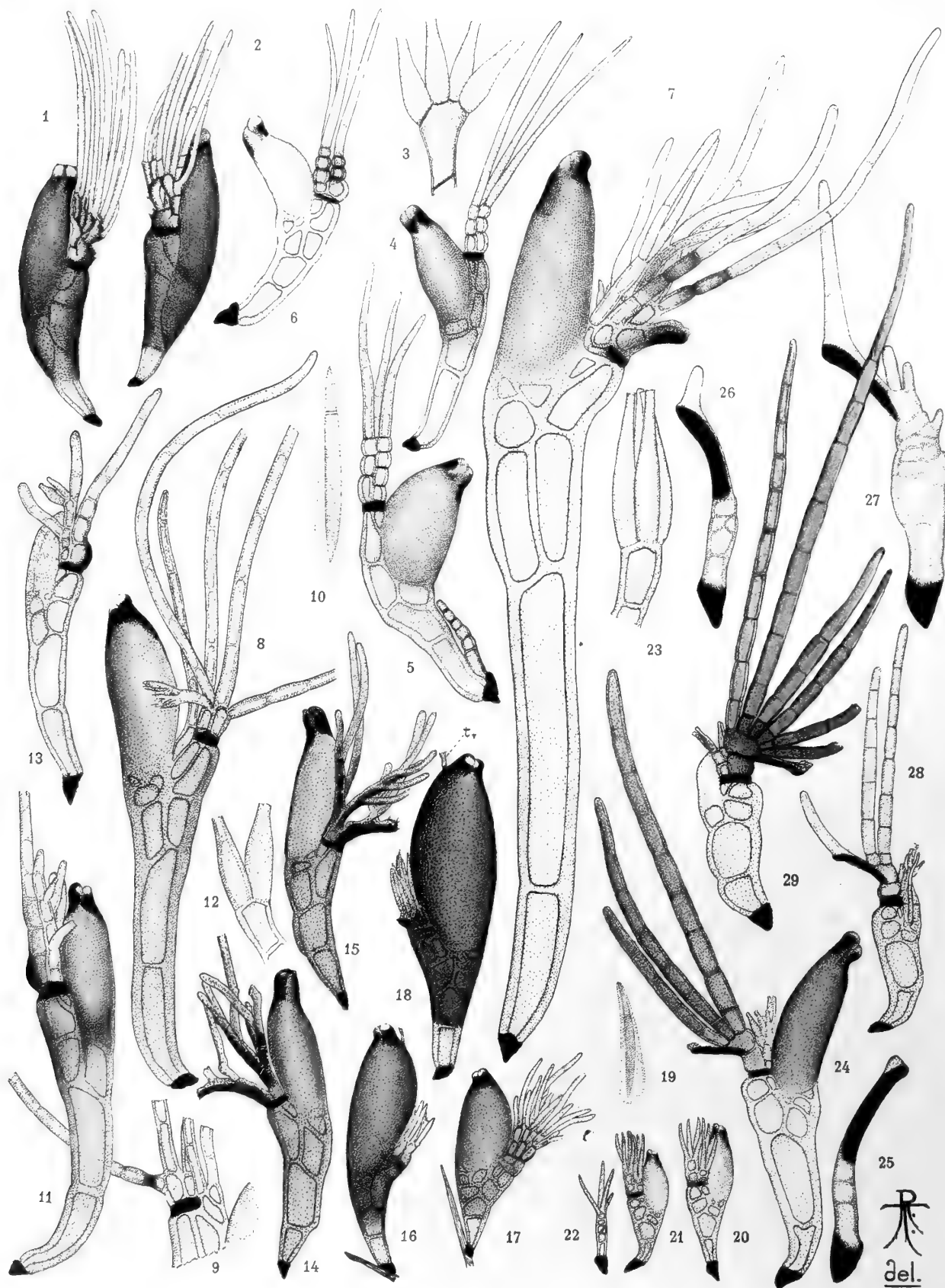
Laboulbenia parvula Thaxter.

- Figs. 22, 23. Two mature individuals. A 12.
Fig. 24. Spore. D 4.



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DESCRIPTION OF PLATE XVII.

Laboulbenia zanzibarina Thaxter.

Figs. 1, 2. Two mature individuals. A 12.

Fig. 3. Branch of fertile appendage with four antheridia. D 12.

Laboulbenia inflata Thaxter.

Figs. 4-6. Three mature individuals. Fig. 6 shows aborted member of same spore pair at the left. A 12.

Laboulbenia Quedii Thaxter.

Fig. 7. Mature individual. A 12.

Laboulbenia proliferans Thaxter.

Fig. 8. Mature individual on *Eudema tropicum*. A 12.

Fig. 9. Structure at base of appendages. On *Chlænius auricollis*.

Fig. 10. Spore. D 4. Fig. 23. Groups of antheridia on fertile branch. D 12.

Laboulbenia Catoscopi Thaxter.

Fig. 11. Mature individual. A 12.

Fig. 12. Branch with antheridia. D 12.

Fig. 13. Young individual. A 12.

Laboulbenia Coptoderae Thaxter.

Figs. 14, 15. Two mature individuals. A 12.

Laboulbenia curtipes Thaxter.

Figs. 16-18. Three mature individuals; the base of the old trichogyne persists below the apex in 16 and 18. A 12.

Fig. 19. Spore. D 4.

Laboulbenia Hageni Thaxter.

Figs. 20, 21. Two mature individuals. A 12.

Fig. 22. Young individual. A 12.

Laboulbenia cristata Thaxter (See also Plate II.)

Fig. 23. Mature individual. A 12.

Figs. 25-27. Three young individuals, showing successive stages. D 4.

Figs. 28, 29. Two more advanced conditions. A 12.

DESCRIPTION OF PLATE XVIII.

Laboulbenia arcuata Thaxter.

- Figs. 1, 2. Two mature individuals. A 12.
Fig. 3. Part of fertile branch with antheridium. D 12.
Fig. 4. Spore pair. D 4.

Laboulbenia macrotheca Thaxter.

- Figs. 5-7. Mature individuals. Fig. 6 the typical form. A 12.
Fig. 8. Spore. D 4.

Laboulbenia Kunkeli (Giard).

- Fig. 9. Mature individual. A 2.
Fig. 10. Young individual. A 2.

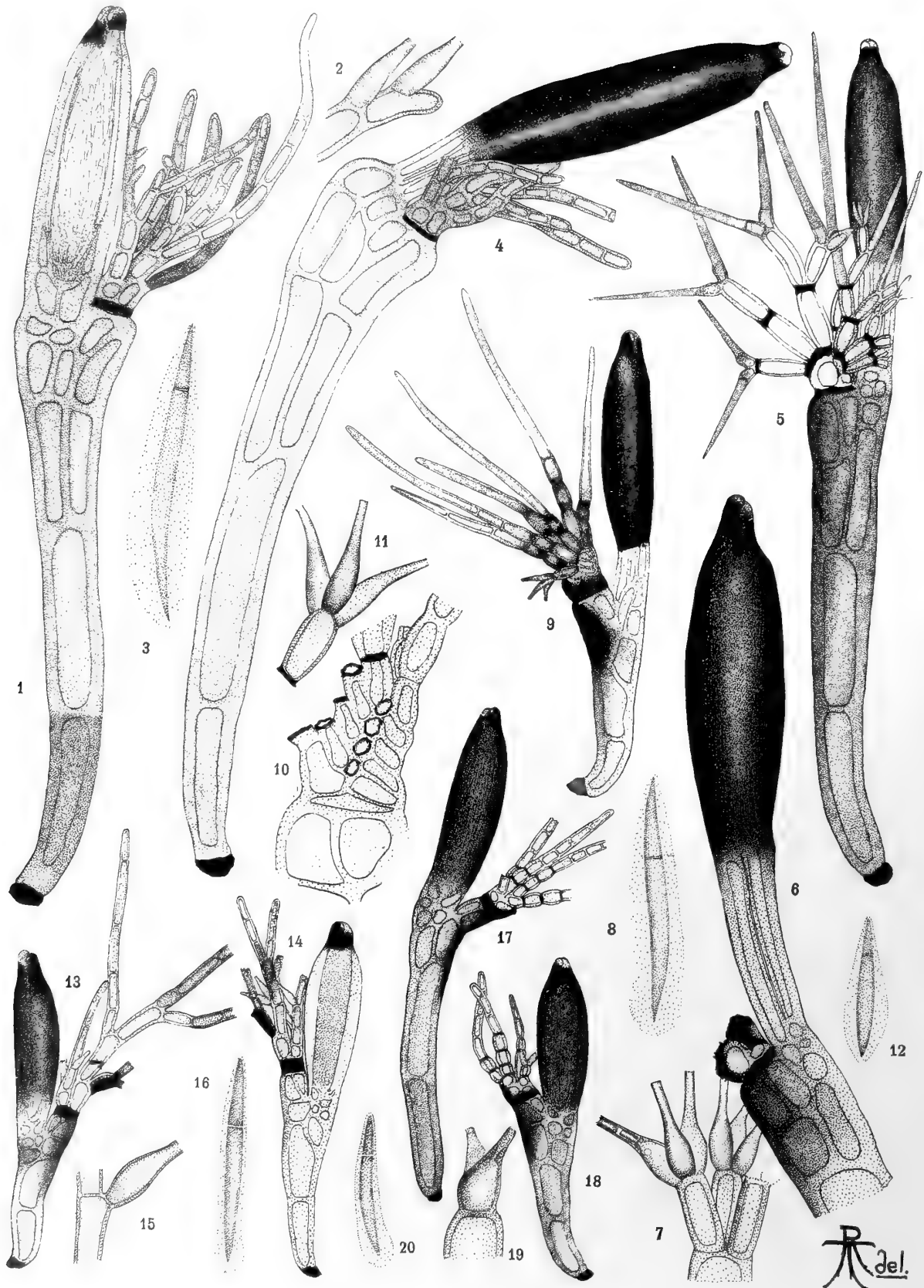
Laboulbenia palmella Thaxter.

- Figs. 11, 12. Two mature individuals, lateral and posterior views. A 2.
Fig. 13. Young individual with trichogyne. A 2.
Figs. 14, 15. Two young individuals. A 2.
Figs. 16-18. Anterior lateral and posterior views of tip of perithecium. D 2.
Fig. 19. Tip of branch of inner appendage bearing branch with antheridia. D 12.
Fig. 20. Spore. D 4.



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DESCRIPTION OF PLATE XIX.

Laboulbenia mexicana Thaxter.

- Fig. 1. Mature individual. A 12.
- Fig. 2. Branch with antheridia. D 12.
- Fig. 3. Spore. D 4.

Laboulbenia melanotheca Thaxter.

- Fig. 4. Mature individual. A 12.

Laboulbenia longicollis Thaxter.

- Fig. 5. Mature individual. A 12.
- Fig. 6. Mature individual: terminal portion, the branches all broken from the basal cells of the appendages. A 12.
- Fig. 7. Branches of inner appendage with groups of antheridia. D 12.
- Fig. 8. Spore.

Laboulbenia Galeritæ Thaxter.

- Fig. 9. Mature individual. A 12.
- Fig. 10. Lateral view of base of appendages, showing insertion of branches.
- Fig. 11. Fertile branch of inner appendage with three antheridia. D 12.
- Fig. 12. Spore. D 4.

Laboulbenia australiensis Thaxter.

- Fig. 13. Mature individual. A 12.
- Fig. 14. Younger individual, showing thick perithecial wall. A 12.
- Fig. 15. Antheridium. D 12.
- Fig. 16. Spore. D 4.

Laboulbenia Panagæi Thaxter.

- Figs. 17, 18. Two mature individuals. A 12.
- Fig. 19. Two antheridia. D 12.
- Fig. 20. Spore. D 4.

DESCRIPTION OF PLATE XX.

Laboulbenia Brachini Thaxter.

- Fig. 1. Short form with appendages well developed. A 12.
Fig. 2. Elongate form with exceptionally simple appendages. A 12.
Figs. 3, 4. Young individuals. D 2.
Figs. 5, 6. Young individuals. D 4.
Fig. 7. Fertile branch with characteristic group of antheridia. D 12.
Fig. 8. Spore. D 4.

Laboulbenia Pachytelis Thaxter.

- Fig. 9. Mature individual with abnormal septa in cells I and II. A 12.
Fig. 10. Mature individual, shorter form. A 12.
Fig. 11. Fertile appendage with two antheridia. D 12.
Fig. 12. Spore pair. D 4.

Laboulbenia Pheropsophi Thaxter.

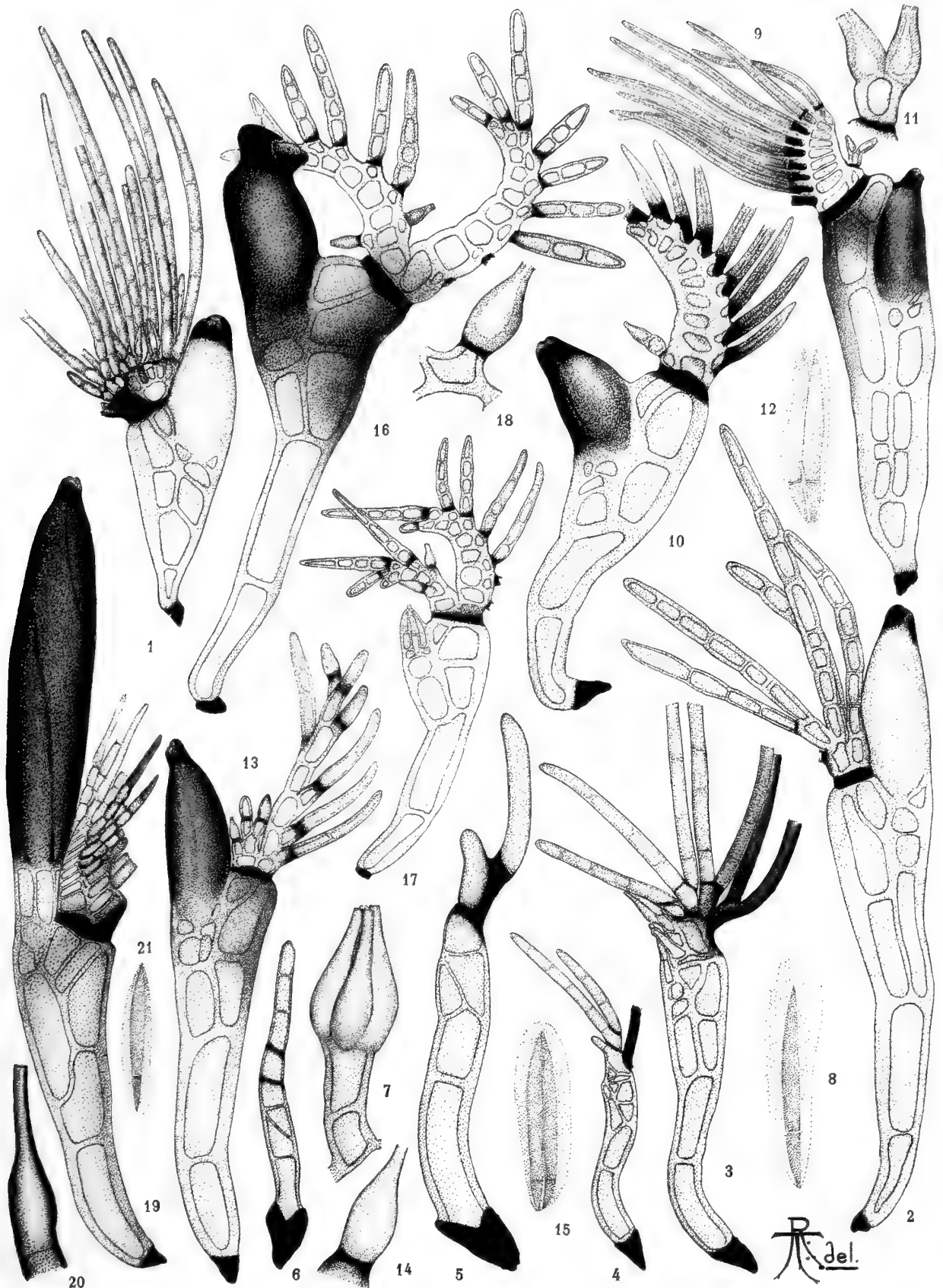
- Fig. 13. Mature individual. A 12.
Fig. 14. Antheridium. D 12.
Fig. 15. Spore pair.

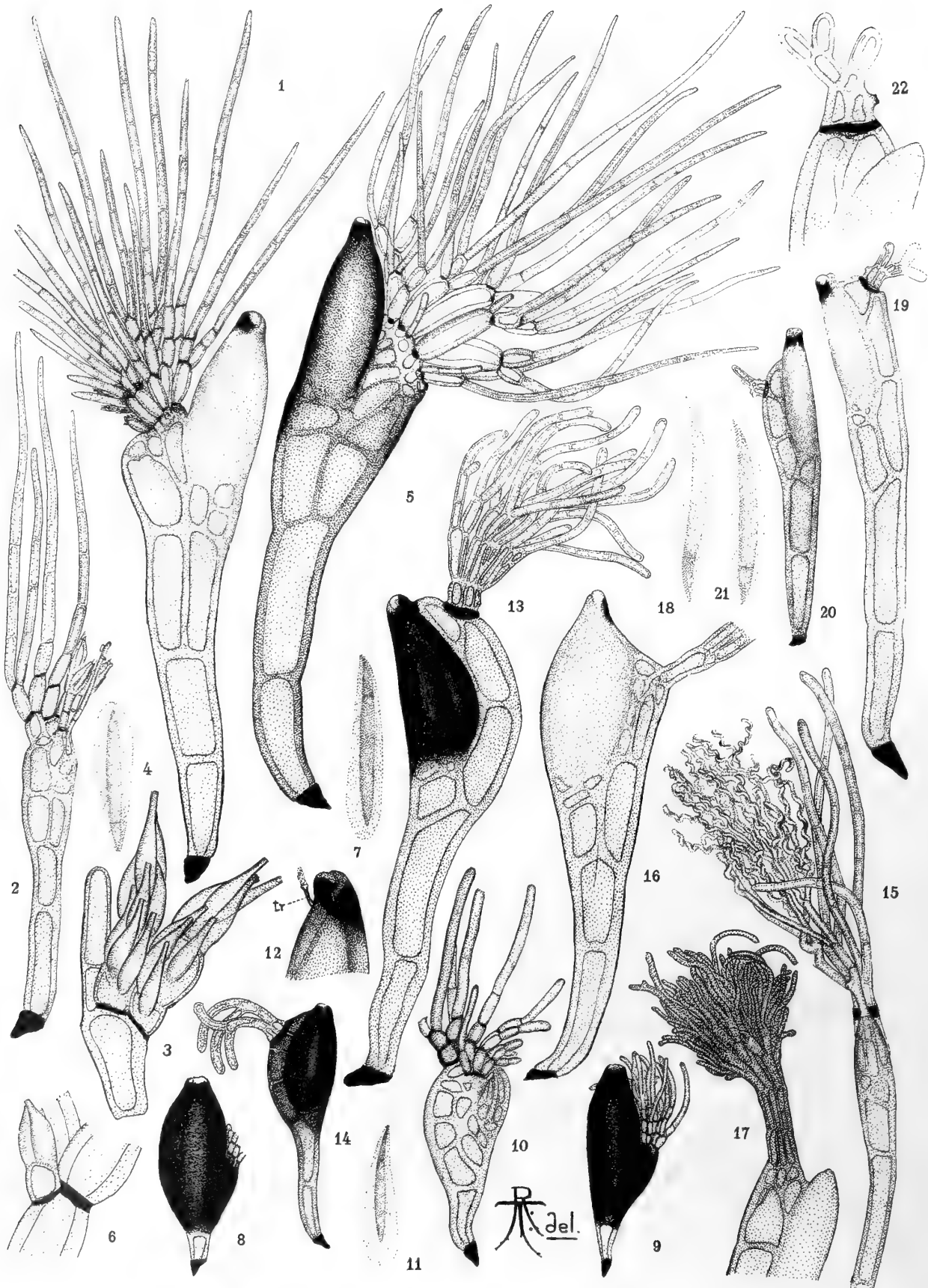
Laboulbenia texana Thaxter.

- Fig. 16. Mature individual. A 12.
Fig. 17. Young individual. A 12.
Fig. 18. Antheridium. D 12.

Laboulbenia decipiens Thaxter.

- Fig. 19. Mature individual. A 12.
Fig. 20. Antheridium. D 12.
Fig. 21. Spore. D 4.





DESCRIPTION OF PLATE XXI.

Laboulbenia variabilis Thaxter.

- Fig. 1. Mature individual. A 12.
- Fig. 2. Young individual, trichogyne with antherozoids *in situ*. D 2.
- Fig. 3. Fertile branch with groups of antheridia. D 12.
- Fig. 4. Spore. D 4.
- Fig. 12. Tip of perithecium, the base of old trichogyne at the left. D 4.

Laboulbenia brachiata Thaxter.

- Fig. 5. Mature individual. A 12.
- Fig. 6. Part of fertile branch with antheridia. D 12.
- Fig. 7. Spore. D 4.

Laboulbenia minima Thaxter.

- Figs. 8, 9. Mature individuals. A 12.
- Fig. 10. Young individual. D 4.
- Fig. 11. Spore. D 4.
- (Fig. 12. See *sub L. variabilis*.)

Laboulbenia Schizogenii Thaxter.

- Fig. 13. Mature individual. A 12.
- Fig. 14. Mature individual, small form. A 12.
- Fig. 15. Young individual, anterior view, showing highly developed trichogyne with spirally coiled extremities.

Laboulbenia Clivinæ Thaxter.

- Fig. 16. Mature individual, the branches of the appendage broken off. A 12.
- Fig. 17. Tip of young individual, showing unbroken appendage. A 12.
- Fig. 18. Spore. D 4.

Laboulbenia Morionis Thaxter.

- Figs. 19, 20. Two mature individuals. A 12.
- Fig. 21. Spore. D 4.
- Fig. 22. Terminal portion of young individual, showing unbroken appendages. D 4.

DESCRIPTION OF PLATE XXII.

Laboulbenia luxurians Peyritsch.

- Fig. 1. Mature individual. A 12.
Figs. 2-7. Young individuals, showing successive stages of development. D 2.
Fig. 8. Spore. D 10.

Laboulbenia fumosa Thaxter.

- Figs. 9-17. Successive stages of development from germinating spore. D 2.
Fig. 18. Mature individual. A 12.
Fig. 19. Antheridium. D 12.
Fig. 20. Spore. D 4.

Laboulbenia confusa Thaxter.

- Fig. 21. Mature individual. A 12.
Fig. 22. Young individual with unbroken appendages. A 12.

Laboulbenia compacta Thaxter.

- Fig. 23. Mature individual. A 12.
Fig. 24. Young individual. D 2.
Fig. 25. Spore. D 4.

Laboulbenia Philonthi Thaxter.

- Fig. 26. Mature individual. A 12.
Fig. 27. Young individual, showing divisions of basal cell of inner appendage. A 12.
Fig. 28. Young individual with peculiarly modified basal cell. D 2.
Fig. 29. Tip of perithecium with trichogyne. D 4.
Fig. 30. Spore. D 4.

Laboulbenia Gyrinidarum Thaxter.

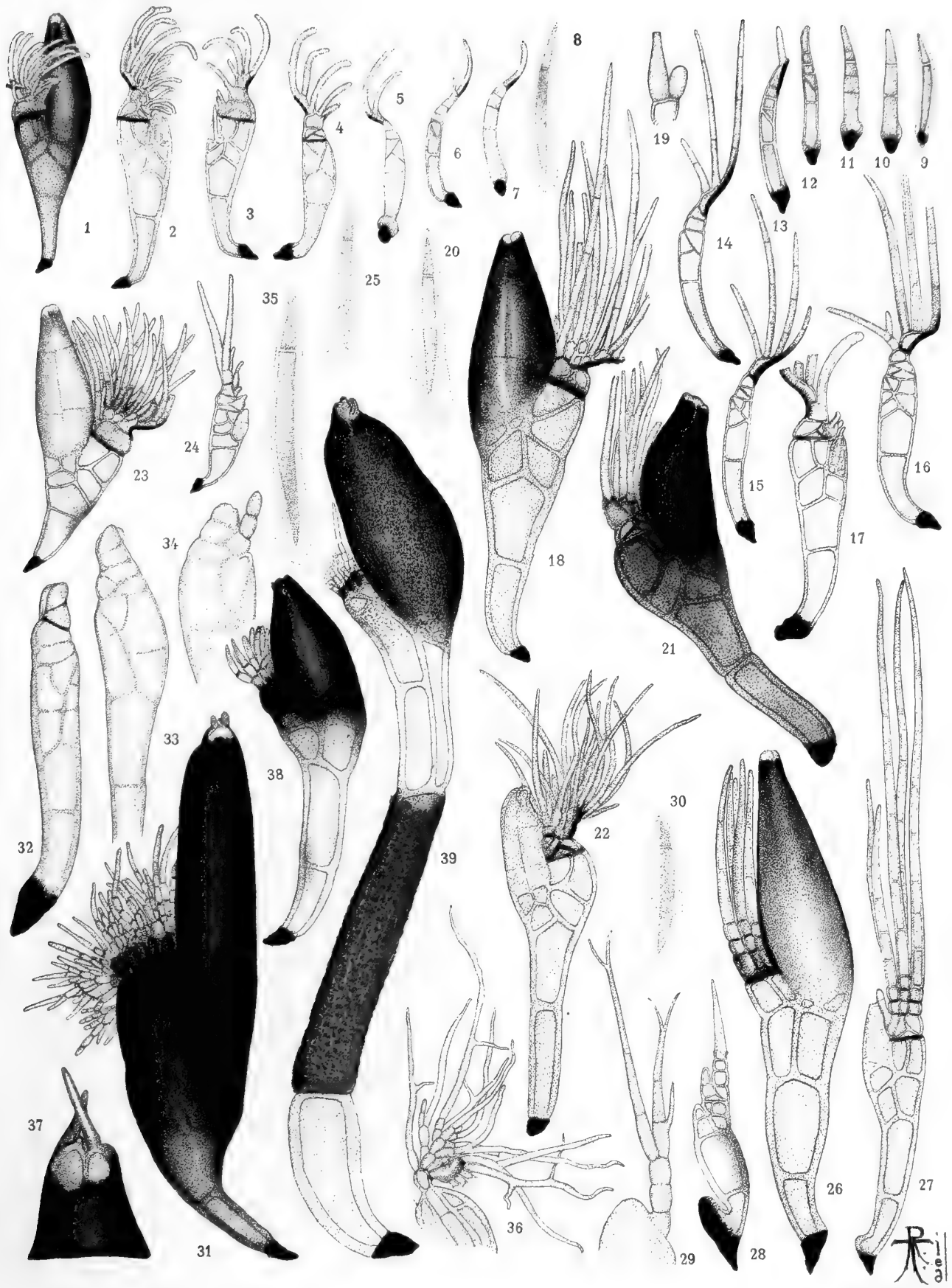
- Fig. 31. Mature individual. A 12.
Figs. 32-34. Young individuals, showing cell-structure at base of appendages. One of the characteristic branches is just beginning to develop at the right in Fig. 34. D 2.
Fig. 35. Spore. D 4.
Fig. 36. Trichogyne. D 2.
Fig. 37. Tip of perithecium enlarged.

Laboulbenia Guerinii Robin.

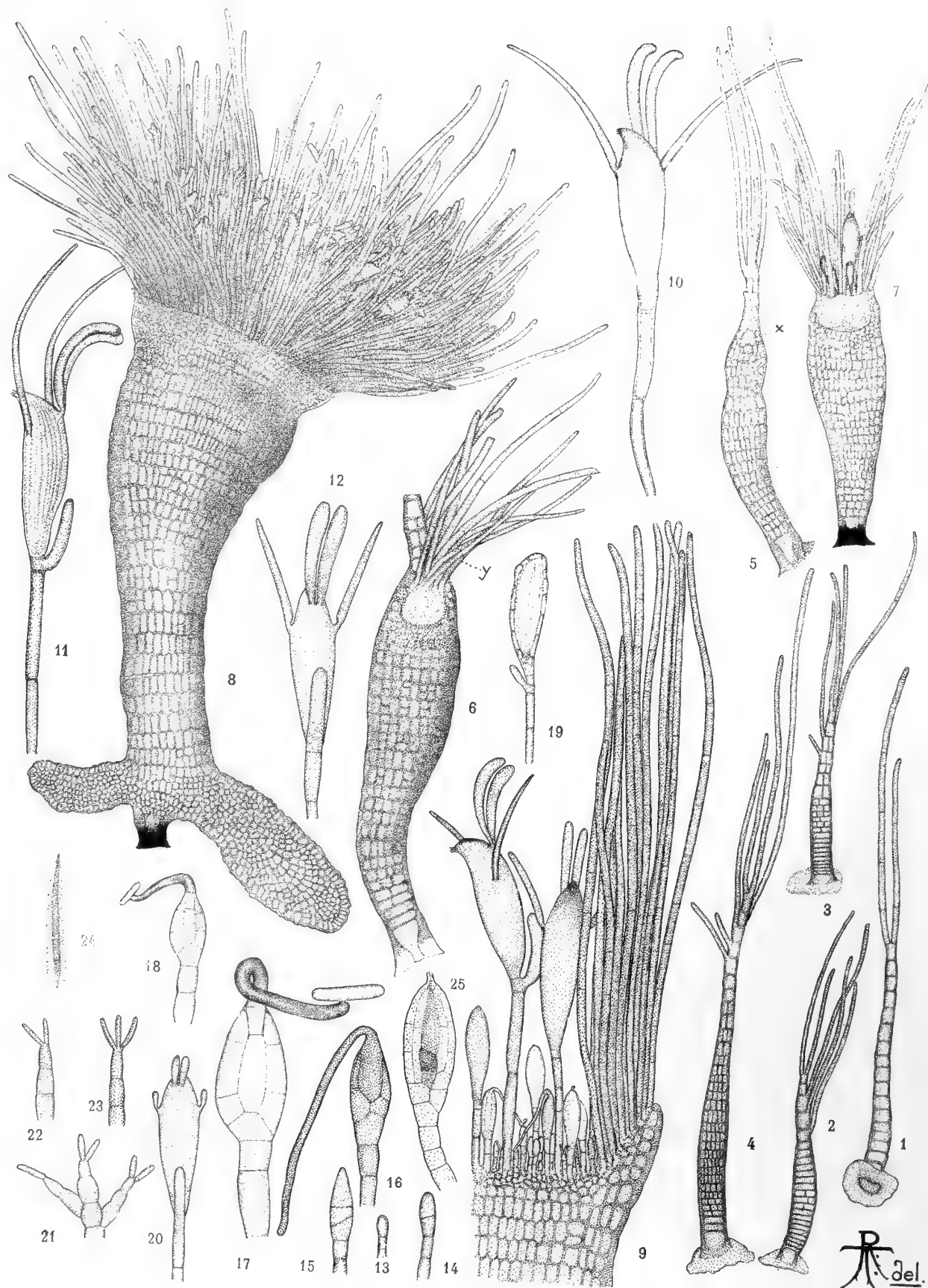
- Fig. 38. Mature individual. A 12.

Laboulbenia Oberthuri Giard.

- Fig. 39. Mature individual. A 4.



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PLATE XXII



DESCRIPTION OF PLATE XXIII.

Zodiomyces vorticellarius Thaxter.

- Figs. 1-4. Young individuals in various stages of development. D 2.
- Fig. 5. Young individual. A cavity is forming above the perithecigerous cells. D 2.
- Fig. 6. Young individual, the upper portion of the receptacle seen in optical section. The end of the primary appendage at the left has been broken off. The secondary appendages have burst through the superficial cells at the apex of the receptacle, and the perithecia are beginning to arise from the perithecigerous cells at the base of the cup-like cavity. D 2.
- Fig. 7. More mature individual, the optical section of its cup-like extremity indicated in part. The primary appendage has disappeared, and one perithecium is nearly mature. A 12.
- Fig. 8. Mature individual. A 12.
- Fig. 9. Section of portion of extremity showing cup-like form, the secondary appendages on the right arising from the inner surface of its rim distinct from the central fertile cells, from which arise antheridia and perithecia in various stages of development. Drawn and partly reconstructed from a microtome section. D 4.
- Figs. 10-12. Anterior, lateral, and posterior views of mature perithecia. D 4.
- Figs. 13-15. Very young perithecia, showing origin as terminal cell (fig. 13), and two further divisions of this cell. J 4.
- Fig. 16. Young perithecium. J 4.
- Fig. 17. Young perithecium with trichogyne and conjugating antherozoid. Leitz oil $\frac{1}{2}$ + 12.
- Fig. 18. A similar stage. D 12.
- Fig. 19. Young perithecium before development of its appendages, lateral view. D 4.
- Fig. 20. Young perithecium: its appendages beginning to bud out, posterior view. D 4.
- Figs. 21-23. Antheridial branches, bearing exogenous antherozoids. D 12.
- Fig. 24. Spore. D 4.
- Fig. 25. Young perithecium in which the ascogenic cell has divided, the trichogyne having withered and broken off. J 4.

DESCRIPTION OF PLATE XXIV.

Ceratomyces mirabilis Thaxter.

- Fig. 1. Mature individual, showing spores and asci within the perithecium. A 12.
Fig. 2. Younger individual, surface view. A 12.
Fig. 3. Young individual. A 12.
Fig. 4. The same, enlarged to show the cell-structure at the base of the appendage. The young trichogyne is developing at the right. D 12.
Fig. 5. Young individual, the branched trichogyne arising between the base of the appendage and the developing perithecium. A 12.
Fig. 6. Individual younger than the last with simple trichogyne, and two conjugating antherozoids (?). A 12.
Fig. 7. The same, showing the base of the trichogyne and its cell-connections. The perithecium just beginning to develop at the left. Compare the younger condition seen in fig. 4. D 12.
Fig. 8. Growing tip of perithecium, showing cell-arrangement (cc) canal-cells, (wc) wall-cells. D 4.
Fig. 9. Ascus with ascospores. D 4.
Fig. 10. Ascospore. D 4.

Ceratomyces confusus Thaxter.

- Figs. 11, 12. Two mature individuals. A 12.

Ceratomyces camptosporus Thaxter.

- Fig. 13. Pair of ascospores. D 4.
Fig. 14. Mature individual. A 12.

Ceratomyces filiformis Thaxter.

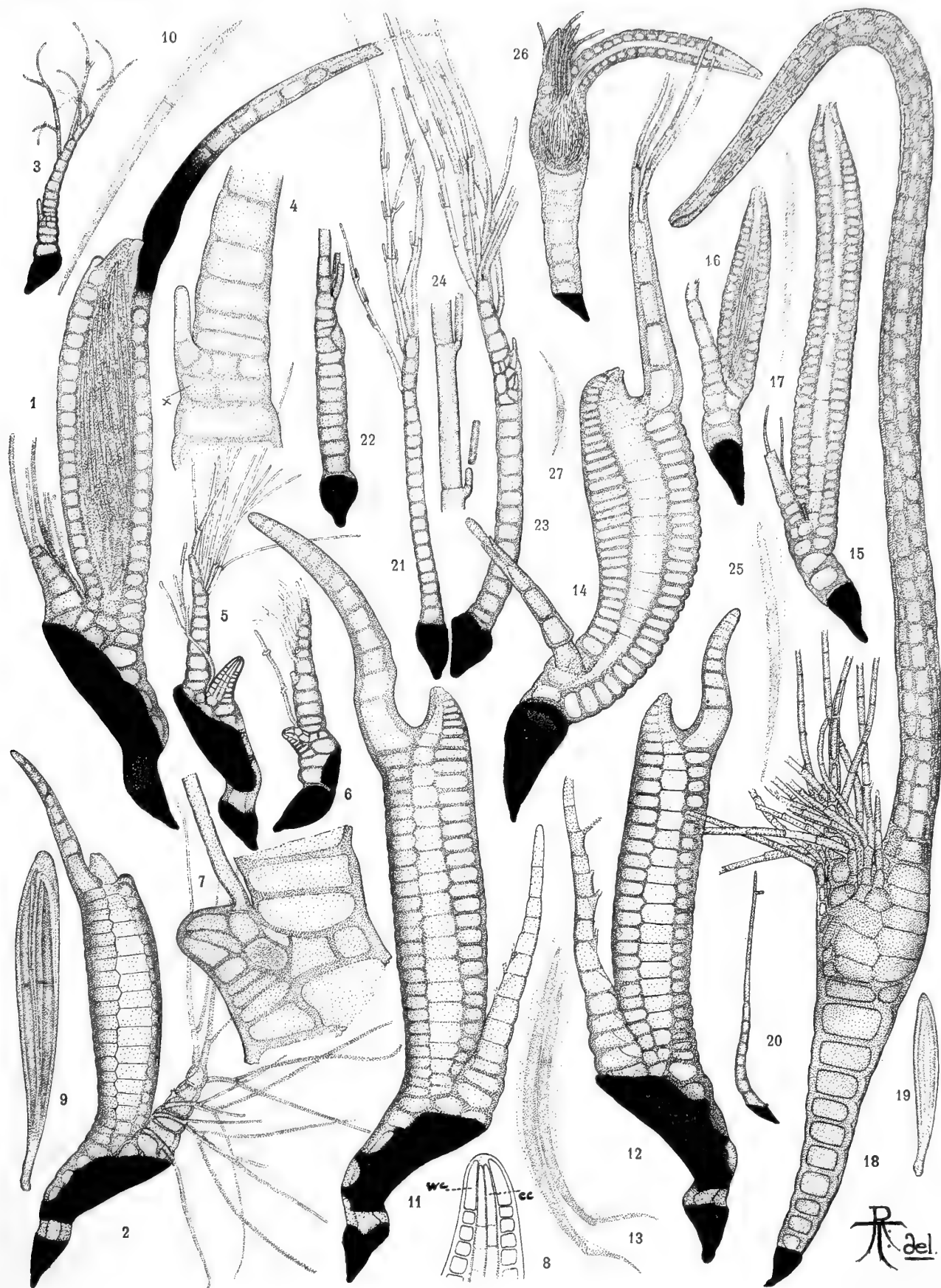
- Figs. 15, 16. Two mature individuals. A 12.
Fig. 17. Ascospore. D 4.

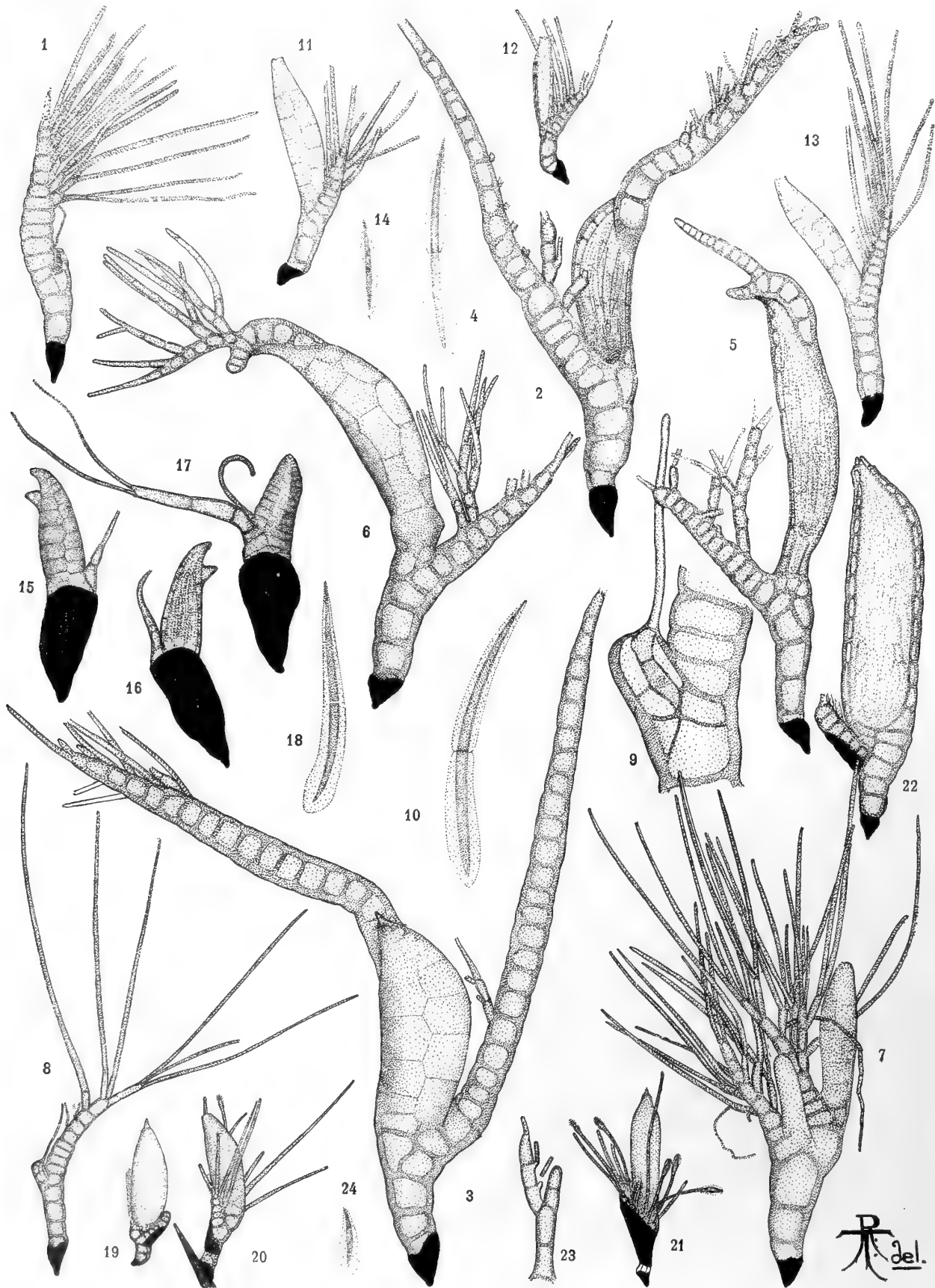
Ceratomyces rostratus Thaxter.

- Fig. 18. Mature individual fully developed. A 12.
Fig. 19. Ascus with immature ascospores. D 4.
Figs. 20-23. Young individuals in various stages of development, Figs. 23, 24 showing exogenous antherozoids. A 12.
Fig. 24. Portion of fertile branch, showing antherozoids. D 12.
Fig. 25. Ascospore. D 4.

Ceratomyces rostratus var.

- Fig. 26. Mature individual. A 12.
Fig. 27. Ascospore. D 4.





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DESCRIPTION OF PLATE XXV.

Ceratomyces furcatus Thaxter.

- Fig. 1. Young individual with trichogyne. A 12.
- Fig. 2. Mature individual, the perithecium in optical section. A 12.
- Fig. 3. Mature individual, surface view. A 12.
- Fig. 4. Ascospore. D 4.

Ceratomyces contortus Thaxter.

- Fig. 5. Mature individual, the perithecium seen in optical section. A 12.
- Fig. 6. Mature individual, surface view. A 12.
- Fig. 7. Abnormal individual, producing two perithecia. A 12.
- Fig. 8. Young individual with trichogyne. A 12.
- Fig. 9. The same, showing cell-connections of trichogyne. D 12.
- Fig. 10. Spore. D 4.

Ceratomyces humilis Thaxter.

- Figs. 11-13. Mature individuals. A 12.
- Fig. 14. Spore. D 4.

Ceratomyces minisculus Thaxter.

- Figs. 15, 16. Mature individuals. A 12.
- Fig. 17. Younger individual with old trichogyne. A 12.
- Fig. 18. Spore. D 4.

Ceratomyces terrestris Thaxter.

- Figs. 19-21. Mature individuals, showing various degrees of blackening in the receptacle. A 12.
- Fig. 22. A mature individual, enlarged sectional view. D 4.
- Fig. 23. Appendage bearing antheridia. D 12.
- Fig. 24. Spore. D 4.

DESCRIPTION OF PLATE XXVI. See also Plate VI.

Chitonomyces simplex Thaxter.

Figs. 1, 2. Two mature individuals. D 2.

Fig. 3. Spore. D 4.

Chitonomyces Bidessarius Thaxter.

Figs. 4, 5. Two mature individuals. D 2.

Chitonomyces aurantiacus Thaxter.

Figs. 6, 7. Two mature individuals. D 2.

Chitonomyces borealis Thaxter.

Figs. 8, 9. Two mature individuals. D 2.

Chitonomyces hyalinus Thaxter.

Figs. 10, 11. Two mature individuals. D 2.

Chitonomyces affinis Thaxter.

Figs. 12, 13. Two mature individuals. D 2.

Fig. 14. Spore. D 4.

Chitonomyces lichanophorus Thaxter.

Fig. 15. Mature individual. D 2.

Fig. 16. Spore. D 4.

Chitonomyces rhyncostoma Thaxter.

Figs. 17, 18. Two mature individuals. D 2.

Chitonomyces melanurus Peyritsch.

Fig. 19. Mature individual. The insertion of the appendage projects as a papilla from the inner margin of the blackened portion. D 2.

Chitonomyces marginatus Thaxter.

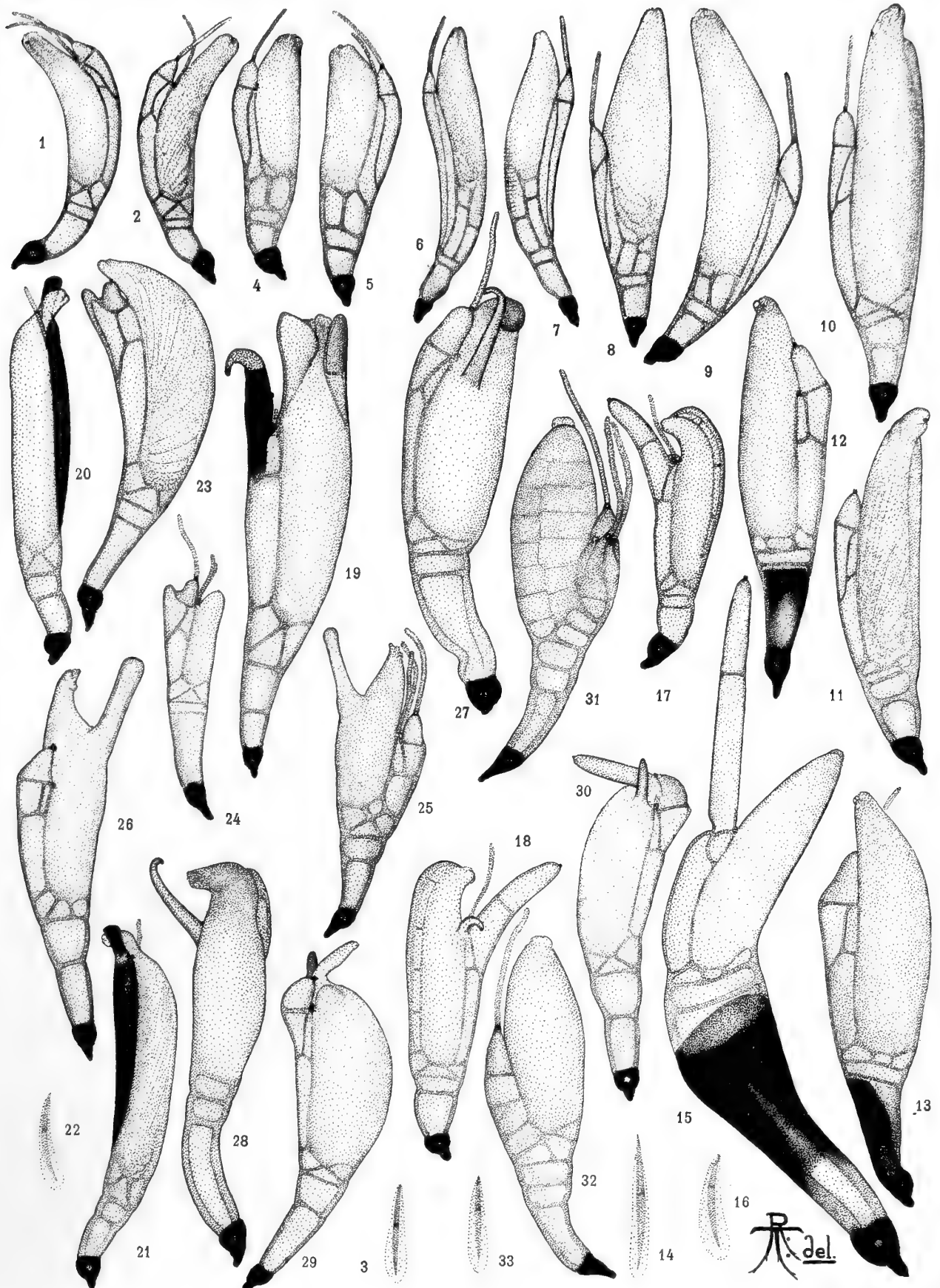
Figs. 20, 21. Two mature individuals. D 2.

Fig. 22. Spore. D 4.

Chitonomyces uncinatus Thaxter.

Fig. 23. Mature individual. D.

Fig. 24. Young individual. D 2.



Chitonomyces appendiculatus Thaxter.

Figs. 25, 26. Two mature individuals. D 2.

Chitonomyces uncigerus Thaxter.

Figs. 27, 28. Two mature individuals. D 2.

Chitonomyces distortus Thaxter.

Figs. 29, 30. Two mature individuals. D 2.

Hydræomyces Halipli Thaxter.

Figs. 31, 32. Two mature individuals. D 2.

Fig. 33. Spore. D 4.

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